U.S. Department of Transportation

A Case Book of Short-Range Actions to Improve Public Transportation

February 1983

Technical Assistance—an UMTA Program

The cover symbolizes the travel markets served by public transportation innovations: Home-to-Work travel; Special User Group travel; and General Purpose travel. The changing administrative and regulatory environment also is depicted.

A Case Book of Short-Range Actions to Improve Public Transportation

Final Report
February 1983

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FOREWORD

Short-range public transportation improvements--actions which can be effective within one or two years--have received a great deal of attention since the mid-1970s as decisionmakers and planners attempted to respond to new kinds of transportation problems. The urgent need to conserve fuel, the desire to increase travel opportunities for the handicapped, and steadily growing transit deficits all prompted UMTA's Division of Service and Methods Demonstrations to test and monitor a wide range of innovative improvement strategies. Under UMTA sponsorship, the Transportation Systems Center (TSC) of the U.S. Department of Transportation has monitored these tests and documented numerous demonstrations in a series of project evaluation reports.

This document presents standardized case studies for 29 short-range projects which have been monitored carefully by TSC, or, in some cases, by local agencies. We believe that this report will be helpful to planners as a single source of information on the effectiveness of numerous public transportation actions. It will also provide guidance to specific TSC project reports and other references for more detailed documentation on worthwhile actions.

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A NOTE ON MONETARY AMOUNTS

All monetary estimates of costs and benefits for the case studies in this volume are expressed in constant 1980 dollars. These amounts can be converted to current dollar terms by applying the current consumer price index to the 1980 price index of 247.6 (U.S. City Average, base year 1967). The January 1984 dollar was roughly equivalent to 82 cents in 1980.

Chapter 1

SELECTING PROMISING ACTIONS

Short-range public transportation improvements -- actions which can be fully operational within one or two years -- cover a wide range of service alternatives and administrative options. Examples include:

- encouraging employers to subsidize transit passes for their employees;
- involving private providers in the delivery of publicly subsidized services;
- developing programs to promote carpooling and vanpooling;
- designing alternative services for handicapped persons unable to use conventional transit;
- coordinating services to special user groups such as the vulnerable elderly;
- providing taxicab feeder services to conventional bus transit;
- offering travel brokerage services to match users with service providers;
- revising taxicab regulations to encourage new service and provider arrangements; and
- increasing parking prices to discourage private automobile use during congested periods.

Over the past decade, the Urban Mass Transportation Administration (UMTA) of the US Department of Transportation has funded research and demonstration projects to test a variety of short-range improvements, and has monitored a number of innovative schemes implemented by state and local governments. This research and development experience has been reviewed and synthesized into general policy and planning guidelines in a companion volume titled Short-Range Public Transportation Innovations/1/. Both in that volume and in this present volume, discussion of short-range actions has been organized so as to focus on three different travel markets: home-to-work journeys, special user group travel, and general purpose travel.

The companion volume is devoted to discussing the major planning issues in each of the three markets, and the types of changes which have potential for achieving certain objectives. This current report, on the other hand,

/1/ Kirby & Miller (1983).

provides brief case studies for a number of short-range public transportation projects. It complements the policy and planning guidelines volume by providing examples of past or existing projects and their impacts, and by demonstrating how such projects should be appraised.

The individual case studies presented here summarize the general features of each project, develop measures of its benefits, costs, and cost-effectiveness using standardized methods and assumptions, and present these appraisals in a standardized format. The particular projects were selected on two principal criteria. First, in order to develop the cases, it was important that the projects should have been monitored relatively carefully during their implementation. Secondly, they were chosen to alert the reader to strategies which might be of interest in other locations, exemplifying the range of possible actions described in detail in the guidelines. In order to place the case studies in context, therefore, we will first summarize the tenor and main conclusions of that companion volume.

PUBLIC TRANSPORTATION CHALLENGES

As transit patronage and revenues fell during the 1950s and 60s, the public sector became more involved in planning, operating, and financing transit systems. In the early 1970s, short-range public transportation planning focused almost entirely on maintaining and improving existing public transit systems. Planners struggled to maintain and expand effective transit services as urban residents and economic activity shifted from higher density central cities to lower density areas, and as private automobile ownership and use increased. The steady growth in local, state, and federal public transportation subsidies responded to and reinforced public expectations for transit. Fares were kept low to help the disadvantaged and to attract commuters from automobiles, while routes were extended to low density suburbs to provide regional coverage. Transit was called upon not only to serve city centers and to help reduce congestion, but to save energy, improve air quality, and increase mobility for low income, elderly, and handicapped persons.

In the mid-1970s, the pressures of growing transit deficits, the unmet travel needs of handicapped persons, and energy shortages stimulated an aggressive search for cost-effective services to supplement public transit. Several transit agencies developed dial-a-ride services in lower density suburban areas and offered specialized services for elderly and handicapped users. In some cities, private taxicab companies began to offer publicly subsidized shared-ride services for certain user groups. Numerous human service agencies started to provide specialized transportation services for their clients. Stimulated by the gasoline shortage of 1973-1974, transit agencies, local governments, and large private companies began promoting and operating car- or vanpool programs.

To respond to these changing priorities, the basic institutional framework for planning public transportation improvements was revised in 1975. New federal regulations governing the urban transportation planning process called for greater consideration of short-term, low-capital transportation improvements. This initiative recognized formally that public transportation planning encompassed a range of different services: conventional transit, dial-a-ride, taxicabs, jitneys, subscription buses, and van- and carpool

programs. To ensure that all of these services were included in the planning process, research efforts were designed to develop new planning procedures and to conduct demonstration projects and case studies of innovative techniques.

Today two primary forces challenge public transportation planners and policymakers: the multi-faceted, changing nature of urban travel, and the pressures on public subsidy budgets. To meet these challenges, public transportation planners must identify the most cost-effective strategies for pursuing public policy objectives, and must be prepared to revise and adapt these strategies as travel conditions and policy objectives change.

HOME-TO-WORK TRAVEL GUIDELINES

The varied nature of work commuter travel presents markets for a number of different service alternatives. Transit, carpools, vanpools, subscription buses, and jitneys are all needed to respond to the variability among work travelers with respect to origin and destination patterns, temporal variations, attitudes, comfort, user costs, and reliability. By focusing on particular problem locations such as congested corridors and worksites, and developing actions tailored to specific commuter segments, planners can devise effective actions for attracting home-to-work trips into higher-occupancy vehicles. Experience to date suggests the following guidelines:

- The most cost-effective strategy for reducing vehicle miles of travel (VMT) and vehicle trips appears to be the expansion of company-organized ridesharing programs aimed at commuter trips for which transit is not available.

- In most large cities, raising current transit fares for work trips from affluent suburbs would produce significant revenue increases with relatively small ridership losses.

- Serving relatively short trips (less than seven miles) with either subscription buses or commuter vans employing paid drivers has not been a cost-effective strategy for reducing VMT.

- Small-scale carpool or vanpool actions that merely divert transit riders without permitting any cutbacks in transit capacity are not likely to be cost-effective ways of reducing VMT.

- Express transit routes charging low fares over long distances (more than 20 miles) have not been cost-effective ways of serving home-to-work travel.

SPECIAL USER GROUP TRAVEL GUIDELINES

Broad groups of people who are more prone to mobility limitations -- the poor, the handicapped, the elderly, the young -- are often designated for special treatment in public transportation programs. However, planners must consider specific subgroups within each of these general categories in order

to address travel problems adequately. Experience to date suggests the following guidelines:

- Transportation services can be provided efficiently to special user groups in several ways: by volunteers in private cars; through service contracts with human service agencies, transit providers, or private operators; by direct subsidy to the users; or by human service agencies with their own vehicles. The most cost-effective approach depends upon the specific program objectives and local demand and supply conditions.

- While many planners and social service agency representatives advocate greater coordination of transportation programs for special user groups, major start-up and ongoing costs of coordination efforts may well exceed the benefits achieved.

- Travel demand for special user groups occurs at low density: for any given area and time period, only a small number of trips are made. This characteristic makes sharing rides difficult to accomplish, resulting in significantly higher overall costs per trip than most other kinds of travel.

- The benefits of special user group programs have often been enjoyed by relatively small subgroups of the eligible users. Efforts should be made to ensure that the programs reach the most needy subgroups, not just those who find access to the program relatively easy.

- Only small proportions of the trips served to date by these programs would not otherwise have been made. If the programs are to serve more new trips, greater efforts will have to be made to reach eligible users not presently able to travel.

- Dial-a-ride services for special users operated by private taxicab and wheelchair service companies typically cost less per passenger trip than similar services operated by transit agencies. User-side subsidy techniques and other administrative efforts to involve private providers should be well worthwhile.

- Fully accessible bus transit for handicapped users will be cost-effective in some cities, while specialized door-to-door services will be preferable in other cities. Each city needs to tailor its own combination of handicapped services to reflect local demographics, geography, and weather.

GENERAL PURPOSE TRAVEL GUIDELINES

General purpose public transportation programs serve a number of different travel markets in place of, or in addition to, the home-to-work and special user group markets. Experience with general purpose programs suggests the following guidelines:

- While conventional transit services will continue to be the backbone of general purpose public transportation, supplementing transit with paratransit services tailored to specific markets can significantly improve overall productivity.
- Taxicab feeder service to fixed-route transit can be a cost-effective way of providing public transportation coverage in low ridership areas.
- The cost-effectiveness of travel brokerage and coordination activities has not been convincingly demonstrated to date. While some specific activities associated with these broad concepts may be cost-effective, each proposal must be assessed critically.
- Transit fare and service changes targeted at specific markets (such as long distance commuters) are often more cost-effective than across-the-board fare adjustments.
- If transit systems are to make better use of their financial resources, planners will have to monitor individual route performance more accurately to determine the true incremental benefits and costs of proposed service changes.

CHANGING THE ADMINISTRATIVE AND REGULATORY ENVIRONMENT

The environment in which today's local public transportation operates can be regarded as having two sets of elements: those bearing on planning and programming activities, and those defining the operating conditions for services. Steadily increasing governmental involvement in the financing of public transportation has brought numerous new administrative requirements for planning and programming. Planners must now deal with continuing changes in the earmarking of public funds for particular types of expenditures, in requirements for private provider participation, in labor protection procedures, and in mandated service standards for particular user groups. These requirements are beyond the direct control of local planners and decision-makers, and are essentially constraints on local procedures.

The most important influences on the operating conditions for services are state and local regulation of public transportation modes and the management and pricing of automobile use. Since these conditions often can be changed at the local level, planners should consider how various alternatives to existing conditions might improve the performance of public transportation.

Studies of the relaxation of certain taxicab regulations in San Diego, Seattle, Portland, and other cities suggest generally positive impacts for users, the municipal governments, and providers. Information is now available on the effects of removing entry controls for new providers, allowing shared-ride and other types of services, and permitting providers to post their own fares. The results of these studies should assist planners examining arguments for and against taxi regulatory revisions in their own areas.

The management and pricing of automobile use affects the <u>speed</u> and <u>user</u>

cost of the automobile. By physically restricting or pricing private automobile use, policymakers can provide a relative advantage to high-occupancy modes. The planning challenge is to combine automobile disincentives with public transportation improvements in a way that enhances overall transportation system performance. While management and pricing disincentives for automobile use have been employed in only a few US cities, the results of several important examples provide useful planning guidance. The major types of actions deserving consideration are:

- priority lanes for high-occupancy vehicles;
- automobile-free or restricted zones;
- parking or road pricing strategies; and
- parking supply management, including on-street residential parking restrictions.

FUTURE DIRECTIONS

Demographic trends suggest that future travel growth in most cities will be concentrated in medium- to low-density suburban areas, rather than in suburb-to-downtown corridors. In cities with declining populations, central areas are declining more rapidly than the suburbs, while in growing cities central areas are growing less rapidly than the suburbs. These trends call for a reexamination of traditional public transportation plans and policies which have focused almost exclusively on radial travel to and from central areas.

Growing financial pressures on public decisionmaking present additional challenges to public transportation planners. These pressures will make it virtually impossible for policymakers to continue the transit service and pricing policies of the 1970s throughout the 1980s. Greater market segmentation and a wider range of service delivery options will have to be considered in public transportation planning.

Unlike long-range improvements, the short-range actions can be implemented relatively quickly and usually rely primarily on local initiative and funding. Greater emphasis on these short-range alternatives will require changes in the institutional framework for planning and decisionmaking. Regional bodies such as metropolitan planning organizations (MPOs) and transit operating agencies should become more oriented toward providing planning and monitoring assistance to local public and private decisionmakers. In cities such as Baltimore (Maryland), Norfolk (Virginia), and Phoenix (Arizona), transit agencies have become involved in planning and funding a range of service delivery options tailored to specific travel markets. In cities like Washington, DC and Minneapolis-St. Paul where transit agencies apparently have chosen to limit their activities to operating regional transit services, city or county transportation organizations and MPOs are planning and programming short-range public transportation improvements to supplement regional transit.

The transportation problems of the 1970s prompted the development of a wide range of short-range improvement strategies for public transportation.

Experience with these strategies in selected cities has provided a valuable information base for planners and decision-makers, and should stimulate greater interest in the adoption of short-range measures in the future.

Chapter 2

ASSESSING BENEFITS AND COST-EFFECTIVENESS

INTRODUCTION

In the chapters which follow, case studies of almost thirty different projects are organized into four different categories. The first three of these include projects which are aimed at serving particular travel markets: high density home-to-work travel; special user group travel; and general purpose travel. The fourth category deals with projects aimed at restraining private automobile use in order to improve the operating environment for public transportation modes. We chose this classification scheme so as to consider together projects which have generally similar objectives, and to separate projects with quite different objectives. Summary tables at the beginning of each chapter are intended to identify further similarities by grouping projects by the type of area that they serve: large urban, medium urban, or rural and small urban.

Case study projects were selected in part because relatively good information is available about them: most were monitored quite carefully during their implementation. Citations are therefore given to the more extensive source documents from which these case studies were developed, and the interested reader is referred to these sources for greater detail. The cases are discussed in a standardized format in which the general features of the project are first described, and estimates of the benefits, costs, and cost-effectiveness are then derived. Finally, alternative strategies which might have generated similar or greater benefits are also discussed briefly.

As far as is practical, we have followed standardized procedures and used common assumptions in developing the quantitative estimates of benefits and costs, and this chapter discusses these general methodological details. For example, all monetary estimates have been expressed in 1980 dollars, and all of the projects have been appraised over a common five-year program period. Though comparability between the programs is limited by special demographic, geographic, and political characteristics of the program sites, we believe that the quantitative assessments provide useful guidance for planners interested in these short-range improvement strategies. In order to assess the potential of these strategies in their own cities, of course, planners must carry out the calculations using their own data and must evaluate the results within the context of their own institutional conditions.

ESTIMATING THE BENEFITS

The objectives of public transportation programs are generally framed in rather vague terms. Common justifications include to "improve mobility for

the handicapped," "reduce gasoline consumption," "attract travel to the downtown area," and "improve air quality". These general objectives provide the basis on which planners must develop new programs, and the criteria against which such programs must be evaluated.

Typically, these objectives can be grouped into two general categories: improving mobility for certain groups or to certain locations, and reducing the vehicle miles of travel (VMT) associated with a certain level of person travel. Some programs are also concerned with reducing the number of vehicles operating rather than the number of vehicle miles. Programs aimed at reducing demand on parking facilities fall into this latter category, for example. In this volume, we have chosen to assess case study programs primarily in terms of mobility and VMT impacts. However, the data presented generally permit the calculation of vehicle reductions for those interested in these impacts.

Whether the public transportation objectives of a community are mobility improvement or VMT reduction, the benefits generated by a particular public transportation proposal will be determined primarily by its impact on travel. Thus, the first step in estimating these benefits is to determine the extent to which the proposal will influence travel behavior. Benefits independent of actual travel impacts, such as those due to increased <u>options</u> for travel, creation of new public transportation jobs, and enhancement of community image and pride, are not necessarily insignificant, but they are virtually impossible to quantify and are probably best left to the direct judgement of community decisionmakers.

The influence of particular public transportation proposals on travel behavior may be reflected in a change in any of several descriptors of tripmaking:

- the number of trips made;
- the service characteristics and price of travel modes used;
- the purposes for which trips are made;
- the time of day, week, and month at which the trips are made; and
- the origins and destinations of trips.

A project does not necessarily have to change significantly the <u>number</u> of trips made to generate benefits: for some communities a shift in the travel modes used or in the destinations of certain trips may be the major impacts sought by the project.

When the travel impacts of alternative public transportation proposals can be estimated with reasonable accuracy, decisionmakers are in a good position to assess the overall social benefits they generate. Impacts such as increases in the user benefits received by different groups of travelers, reductions in gasoline consumption and air pollution, and likely effects on urban form can all be estimated once the travel responses to new proposals have been predicted. Decisionmakers will value these impacts differently, of course, depending on local community perceptions and on the priorities of

regional, state, and federal agencies with funding or regulatory involvement.

Estimation of the travel impacts of public transportation proposals must be carried out with considerable care if proper guidance is to be provided to the decisionmakers. Certain general methodological points are very important/1/.

For instance, the definition of a trip must be clearly stated and unambiguous in assessments of travel impacts. We use the term "trip" to describe the one-way travel of one person between an origin point and a desired destination point, without any intermediate destinations. "Trip length" refers to the over-the-road distance traveled between the origin and destination. Significant intermediate destinations would imply that the travel be split into more than one trip.

Where the term is used in any other way, it is necessary to identify the meaning explicitly. For example, a public transportation trip involving a transfer may be counted as two "unlinked trips" or as one "linked trip." Since some 10 to 20 percent of public transportation trips are likely to involve transfers, confusion over this latter distinction can produce misleading results. A "revenue trip" is often the same as a "linked trip", except that those made without payment of a fare would not be counted. The distinctions between one-way trips and round trips, and between passenger trips and vehicle trips also cause confusion at times. The fact that trips are sometimes chained together sequentially into "tours" with multiple origins and destinations also must be taken into account in describing travel impacts.

The travel impacts of alternative public transportation proposals should always be estimated with respect to the same base case. Since decisionmakers will be choosing between alternative courses of action (or inaction), it does not particularly matter which base is used: the base is simply a convenient way of ensuring that the impacts of the alternatives are expressed in comparable terms. Perhaps the most commonly used base is the "do-nothing" scenario: travel behavior as it would be in the absence of all the alternative public transportation actions being considered. This base is usually established by extrapolating travel behavior observed at the time the alternatives are being considered. In some cases it may be more convenient to use one alternative as a base: where, for example, a general strategy for action has been selected and the alternatives under consideration are modifications or refinements of that general strategy.

Account must be taken of the development of travel responses over time. A period of six months to one year may be needed for the travel response to even the simplest service change to develop fully, and the responses to some changes may take place over periods of several years. Consequently, the travel responses and associated benefits from short-range public transportation improvements should be estimated over reasonable project lifetimes, and properly discounted to present values for comparison with

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/1/ These "nuts and bolts" issues are discussed briefly in the following pages. More detail will be found in textbooks such as Thompson (1980), Stokey & Zeckhauser (1978), and chapter 7 of Dunn (1981).

alternatives.

Recognition of the effect of time on travel responses is particularly important in the formulation and use of fare and service elasticity measures. Seasonal and secular effects on travel must be taken into account when elasticities are developed, and the distinction between short-run and longer-run elasticities must be kept in mind. Most elasticities used in public transportation planning are actually short-run elasticities; they reflect short-run travel responses but do not take into account possible longer-run responses such as changes in residential or employment locations.

In the case studies presented in this volume, we have chosen to adopt a discount rate of 10 percent per annum. This choice is based on the rationale outlined in Circular A-94 of the US Office of Management and Budget:

> "The prescribed discount rate of 10 percent represents an estimate of the average rate of return on private investment, before taxes and after inflation/2/."

This discount rate is applied to benefits and costs <u>after</u> accounting for inflation; that is, after quantifiable benefits and costs have been expressed in constant dollars. To assess financial feasibility, of course, requires the use of current dollars which anticipate future inflation.

Benefits and costs of the short-range programs described later have been analyzed over program periods of five years. Because these programs typically are fully operational within one year, and because funds are rarely committed for more than five years, a five-year period provides a reasonable lifetime over which to assess alternative programs. Different program periods can be used in different settings, of course, although it is essential for comparability that alternative programs in the same setting be analyzed over the same program period.

Since decisionmakers may place higher values on some trips than on others, <u>the incidence of travel impacts</u> on different population groups usually must be identified explicitly. Trips diverted to a high-occupancy public transportation mode from single-occupant automobiles may be valued more highly than those diverted from other high-occupancy modes, for example. Trips which help promote downtown businesses may be valued more highly than those which encourage suburban business development. And trips made by persons with limited mobility may be valued more highly than those made by those with no significant mobility limitations. Current planning practices often fail to provide sufficient disaggregation of affected travelers for decisionmaking purposes; for example, transit agencies rarely consider passengers by different population groups in their service evaluation procedures.

Public transportation projects often have <u>secondary impacts</u> on travel in addition to the primary impacts sought by the project proponents. Some of these secondary impacts may have a positive effect on the overall benefits generated by the proposals, and others may have a negative effect.

/2/ US Office of Management and Budget (1972).

For example, a dial-a-ride service for the elderly may generate positive secondary impacts by relieving friends and relatives of driving users to and from their trip destinations, but may also generate negative secondary impacts by attracting so many former taxi riders that the taxi operator is forced to reduce the level of service that he can offer to the general public.

Or again, an effective program of carpool, vanpool, and express bus services to a remote residential neighorhood may serve the objective of reducing the VMT generated by home-to-work travel from the neighborhood. However, by making more cars available during the day for use by other family members, the program may generate two kinds of secondary impacts: positive impacts for those making the extra automobile trips, and negative impacts on overall VMT. Such a program may also generate longer-run impacts (both positive and negative, perhaps) by encouraging more families to move to the neighborhoods.

While quantification of these secondary impacts may be more difficult than for the primary impacts, explicit recognition of their existence and likely significance is necessary for the evaluation of alternative proposals.

ESTIMATING THE COSTS AND COST-EFFECTIVENESS

By comparison with the complex task of quantifying the benefits of public transportation programs, the estimation of the costs associated with the programs often appears deceptively easy. The inadequacy of the computation and presentation of costs associated with many recent public transportation programs serves to dispel any presumptions of this kind, however. Not only are the presented costs almost always incomplete, but for some programs costs are virtually impossible to obtain and are undoubtedly unknown even to the administrators and decisionmakers responsible for the programs. The methodological points discussed below are probably the most commonly overlooked in costing public transportation alternatives.

Considerable care must be taken to ensure that all of the relevant costs associated with public transportation proposals are identified and taken into account. While the visible day-to-day costs of operating public transportation services are usually included in planning calculations, costs associated with periodic capital purchases, with planning and administration, and with initial start-up activities for new services are often omitted, or treated only in a cursory manner. There is also a tendency for local agencies to ignore, in their estimation of costs, those which are borne by other levels of government. While this may accurately reflect the costs of alternative proposals to that agency, it makes any review by other government levels more difficult, and limits the value of the planning analyses to interested planners in areas with different cost-sharing arrangements.

Costs should be developed with respect to the same base case as is used for estimating benefits. Explicit specification of this base case should be a first step in the analysis of alternative public transportation proposals to ensure that all costs are expressed in comparable terms. The "do-nothing" scenario often makes a convenient base, although one of the alternative courses of action could also be used.

The costs associated with a particular public transportation project are the additional costs or the cost savings relative to the base case situation. Where project proposals involve relatively small changes to an existing system of services, as in the case of route additions or withdrawals for a major transit system/3/, estimation of the incremental costs is complicated by the relationship of the proposals to the overall system. Withdrawal of a transit route may or may not reduce vehicle fleet requirements, for example, and expansion of a shared taxicab service may or may not require additional dispatching staff. Great care and rather sophisticated analytical techniques are often required to capture accurately the incremental costs of such public transportation proposals/4/.

The development of costs over time during the life of a proposed project requires careful attention for two major reasons. First, the effects of inflation must be taken into account in assessing alternative proposals by expressing costs in constant dollars. (For month-to-month accounting purposes during the course of a project, however, costs will be expressed in current dollars.) Second, the fact that funds required for future costs are available for alternative uses in the interim must be taken into account by appropriate discounting to present values. Computing present values of project costs over reasonable project lifetimes also will put into proper perspective the relative contributions of one-time costs (like planning and start-up) and continuing costs (like administration). As with the estimation of benefits, we have chosen to use a 10 percent discount rate and a five-year program period consistently for all of our case studies.

Public transportation improvements are typically funded from several different government financing sources, and it is important that these various sources of financing be identified explicitly and that their respective contributions should be estimated in current dollars. The level of involvement of different funding sources is likely to have a major bearing on the evaluation criteria and administrative requirements which will be placed on the proposal during the review process, and may well limit the kinds of proposals which can be considered. In addition, a comparison of the initial sources of government financing with the ultimate beneficiaries of public transportation improvement is essential for assessing the net equity implications of the improvements. Who benefits from and who pays for particular alternatives are essential inputs to public transportation decisions. (Since many of the case examples reported in this volume were federally-funded demonstration projects, the experience provided on who pays for ongoing programs is unfortunately rather limited.)

It often is helpful to scale the costs of alternative proposals by some measure of their travel impact, such as the VMT reduced or passenger trips served. The resulting measures, such as cost per VMT reduced or cost per passenger trip served, describe the cost-effectiveness of the proposals in bringing about particular travel impacts. Such cost-effectivenss measures are useful in comparisons of proposals which are aimed at achieving essentially the same travel impacts. These measures have limited value, however, for

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/3/ Kirby, Green, & Olsson (1979).
/4/ McGillivray, Kemp, & Beesley (1980).

comparisons of proposals which have very different kinds of travel impacts: in these cases a full accounting of all of the benefits and costs associated with each proposal must be undertaken.

IDENTIFYING WORTHY ALTERNATIVES

Public transportation improvements often have been designed and implemented in US cities without even the most cursory consideration of alternatives. In the absence of strict financial criteria, it is easy to "justify" a costly proposal by pointing to some major benefits which are difficult to quantify in monetary terms. In order to ensure that such proposals are really worthwhile it is essential to examine alternative proposals aimed at the same objectives (to determine their relative cost-effectiveness), and to consider proposals which might have somewhat different costs and impacts.

The search for worthy alternatives should always be for those which might be better than the one in hand. A proposal cannot be justified by comparing it with highly inferior alternatives: it must be shown to be superior to all of the alternatives with comparable performance.

But a public transportation proposal is not automatically worth implementing because it is superior to all other public transportation proposals: it should be superior to all alternative uses of the funds involved. While much of the funding used in public transportation projects is actually earmarked for public transportation purposes (particularly that from state and federal sources), there is usually a significant amount of funding involved which could be used for other purposes. The local contribution to public transportation projects is often not dedicated exclusively to that purpose, for example, and local governments must often decide between a public transportation proposal and other public projects, such as housing, road maintenance, or possibly even tax reductions. In this sense, a "spend-nothing" alternative represents the best use of the funds for purposes other than public transportation. Similarly, a comparison of two proposals with different funding levels should recognize that the proposal with the lower funding level leaves some funds available for other purposes.

The public transportation alternatives identified for comparison should include not only the visible "operating" proposals, such as addition of new service routes or reductions in fares, but also the "non-operating" proposals such as planning studies, marketing and promotion, adjustments in work schedules, computerized management and control systems, and brokerage functions. These latter proposals can involve substantial costs and benefits, and should be evaluated in the same terms as operating projects.

Concerns are sometimes expressed that "there are too many alternatives to evaluate fully" and that alternatives analysis requirements cause unnecessary delays in project implementation. One response to such concerns is to improve procedures for identifying worthy alternatives: those relatively few alternatives which deserve serious consideration. If better guidance can be developed on isolating the worthy options for achieving certain kinds of benefits, a rigorous examination of alternatives can be conducted without elaborate and time-consuming technical studies.

Chapter 3

HIGH-DENSITY HOME-TO-WORK TRAVEL EXAMPLES

A GUIDE TO EXAMPLE PROGRAMS

The first type of project to be considered comprises those directed specifically at the high-density home-to-work market. In this market segment, travelers make regular daily trips at densities which offer potential for high-occupancy modes such as carpools, commuter vans, subscription buses, and conventional transit. The experience documented to date with programs aimed at home-to-work travel provides some valuable guidance to planners on designing such programs.

Exhibits 1 through 3 list a number of examples of home-to-work programs in areas of different sizes, and summarize the general characteristics of each of the programs. Detailed case studies for several of these programs -- those with a case study number -- follow. Some of the cases are described with more methodological detail than the others, and these are identified in the exhibits by an asterisk following the identification number.

For the examples listed in the exhibits which have not been chosen for case study treatment, Exhibit 4 provides references to sources of more detailed information.

Exhibit 1: HOME-TO-WORK EXAMPLES FOR LARGE URBAN AREAS

Example, and case study number	setting	population size (P) or number of employees (E)	type of service	provider arrangements
H1.* Aerospace/SAMSO, El Segundo (Ca.)	suburban	5,800 (E)	transit, carpool, vanpools	private company
H2. El Segundo (Ca.)	suburban	18,000 (E)	express bus	transit agency
Los Angeles (Ca.)	urban	varies	subscription bus	private operator
H3. Minneapolis (Mn.)	suburban	70,000 (E) (11 sites)	transit, carpool vanpools	transit agency, vanpool assoc.
Reston (Va.)	suburban Washington, (DC)	25,000 (P)	subscription bus, vanpools	non-profit residents' assoc.
H4.* San Francisco (Ca.)	suburban corridor	35,000 commuters	vanpools, transit carpools	transportation authority
H5. Seattle (Wa.)	CBD	20,000 (E)	promote flexible work hours	ridesharing agency
H9. Seattle (Wa.)	urban	1.4 million (P)	transit	part-time drivers
H6. 3M, St. Paul (Mn.)	suburban	10,000 (E)	vanpools for short trips	private company

* Case studies developed in greatest methodological detail.

Exhibit 2: HOME-TO-WORK EXAMPLES FOR MEDIUM-SIZED URBAN AREAS

	Example, and case study number	setting	population size (P) or number of employees (E)	type of service	provider arrangements
	Knoxville, (Tn.)	four counties	150,000 (P)	carpools, vanpools	individuals and companies, city agency as broker
	Norfolk (Va.)	naval base	86,000 (P)	vanpools	transit agency/ Navy
H7.	Sacramento (Ca.)	CBD and suburban	49,000 (E)	transit pass program	regional agency
H8.*	TVA, Knoxville (Tn.)	CBD	3,000 (E)	transit, carpool,	private corporation

* Case studies developed in greatest methodological detail.

Exhibit 3: HOME-TO-WORK EXAMPLES FOR RURAL & SMALL URBAN AREAS

Example, and case study number	setting	population size (P) or number of employees (E)	type of service	provider arrangements
Bremerton (Wa.)	small town navy yard	35,000 (P)	subscription bus	private operator
Specialty transit, St. Louis (Mo.)	rural towns	30,000 (E)	subscription bus	private operator
Viking/Breckenridge (Mn.)	rural	150 (E)	2 vans	company operated, paid drivers

Exhibit 4: REFERENCES FOR EXAMPLES NOT USED AS CASE STUDIES

type of area	example	source of further information
LARGE URBAN	Los Angeles (Ca.)	McCall (1977)
	Reston (Va.)	Furniss (1977)
MEDIUM URBAN	Knoxville (Tn.)	Juster (1980)
	Norfolk (Va.)	Furniss (1979)
RURAL & SMALL URBAN	Bremerton (Wa.)	US Department of Transportation (1976)
	Specialty transit, St. Louis (Mo.)	Kirby & Bhatt (1975)
	Viking/Breckenridge, (Mn.)	Minnesota Department of Transportation (1980b)

Case Study H1: Aerospace/SAMSO Ridesharing Program

The Areospace Corporation and the Air Force Space and Missile Organization (SAMSO) together employ over 6,000 persons in the El Segundo Employment Center, located near the Los Angeles International Airport. The site has good freeway access and free parking in widely dispersed parking lots. Since 1973, a group of transportation specialists at Aerospace has been developing and implementing a program designed to reduce VMT associated with work travel to and from the site.

The Aerospace/SAMSO program began with a subscription bus service introduced in November 1973, followed by a carpool matching program implemented in 1974 at the time of the gasoline shortages. Although the subscription bus service was abandoned early in 1974 after the bus company raised fares substantially, many of the bus riders formed carpools and, as shown in table H.1.1 carpool usage increased dramatically, from 7 percent of all employees in September 1973 to 38 percent in May 1974. This increase was a result of three factors in combination: the gasoline shortage, the carpool matching program, and the termination of the subscription bus program.

Table H1.1 MODAL SHIFTS AT AEROSPACE/SAMSO

	Sept 1973	Nov 1973	May 1974	1975	1978
Approximate total employment	5,800	5,800	5,800	6,500	6,500
Percent of employees traveling to work by:					
drive-alone	83%	67%	52%	65%	65%
carpool	7	23	38	23	22
transit	1	1	1	1	1
express bus	4	4	4	4	4
vanpool	-	-	-	2	3
walk, bike, other	5	5	5	5	5

In April 1975 a commuter van program was initiated with vans insured and maintained by Aerospace Corporation. The van drivers organize and maintain their own pools with assistance from the company and from Commuter Computer, a non-profit regional corporation for commuter matching. Aerospace Corporation has continued to maintain a transportation coordination office staffed by a part-time staff member to promote carpools and vanpools. Though carpooling dropped from its 1974 peak of 38 percent to 22 percent in 1978, overall use of high-occupancy modes by Aerospace employees is still substantially higher than

it was in September of 1973. A bus service for short trips which permitted buses to make multiple trips in each rush hour was introduced as an experiment in 1978/1/.

Benefits

The VMT reductions achieved by the Aerospace/SAMSO program appear to have been quite significant, although they can be estimated only approximately from available data. If the entire shift observed between September 1973 and 1978 is attributed to the program, and if this impact is applied to the 1978 employment level of 6,600, the overall daily VMT reduction achieved by the program was 20,500 (table H1.2). This is almost certainly an overestimate, however, for three reasons:

- many of the carpools formed during the gasoline shortages but prior to the Aerospace/SAMSO program would probably have continued even without the program;
- the availability of carpool and vanpool matching services may encourage employees to locate further from the office location than they might have in the absence of the program; and
- cars not used by commuters are probably used to some extent during the day by other members of the family.

Table H1.2: VMT IMPACTS AT AEROSPACE/SAMSO

	Average Vehicle Occupancy*	Average Vehicle Round-Trip (Miles)*	Number of Commuters Shifted	Daily VMT Impact+
Means of travel:				
drive-alone	1.0	28	-1,188	-33,300
carpool	2.5	28	+990	11,100
vanpool	10.0	60	+198	1,700
Total VMT change				-20,500

Notes: * Assumptions, since data are unavailable.
+ A van is considered equivalent to 1.4 cars for VMT purposes

/1/ See Case Study H2 and Schnitt (1980).

Table H1.3 uses the data from the preceding table, to estimate net annual VMT impacts over a five-year program period. The table assumes an initial six month period of linear growth from zero at the outset to the final stable levels shown in table H1.2. An adjustment for additional household travel is included based on an assumption that 15 percent of the households of ridesharers travel an extra 4 miles per day (this assumption is discussed in Appendix A). The impacts shown are intended to reflect five-year expectations for another company or public agency instituting a program like Aerospace/SAMSO. For the second through the fifth years, net VMT reductions have been discounted to present values using a 10 percent discount rate.

Table H1.3 VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	Commuter VMT Reduction	Additional Household Travel	Net Annual VMT Reduction	Present Value
Year 1	3.85	-0.14	3.71	3.71
Year 2	5.13	-0.18	4.95	4.50
Year 3	5.13	-0.18	4.95	4.09
Year 4	5.13	-0.18	4.95	3.72
Year 5	5.13	-0.18	4.95	3.38
Total				19.40
Mean per year				3.88

Notes: All entries are in millions of miles. The exhibit assumes 250 work days per year.

User benefits resulting from the program accrue to the individual employees who are able to find a preferable mode for home-to-work travel. These user benefits can be estimated by halving the cost savings calculated by assuming that all of the program users fomerly drove to work alone in automobiles dedicated solely to that purpose. The rationale for this method is described in Appendix C. Some secondary benefits also may accrue to family members or friends who are able to use a car left at home by a commuter, or who are relieved of driving a commuter to work. The available data do not permit quantification of these benefits, however.

Costs and cost-effectiveness

The data available on the costs of the Aerospace/SAMSO program are very sketchy. The costs of the carpool matching activities in 1974 have been estimated to be about \$12,500, equivalent to \$19,900 in 1980 dollars. The

planning and implementation of the vanpool program involved a committee of about 12 professionals working about four hours a month for about three months, a cost of about $5,900 in 1980. Ongoing maintenance of the program including accounting and finding new riders requires about eight hours a week of administrative time, costing about $135 a week in 1980. The costs of vanpool insurance and leasing are currently covered by user fees, although they initially were underwritten by the company.

In order to make the costs and cost-effectiveness of the Aerospace/SAMSO program meaningful to other companies or public agencies contemplating similar programs, we have calculated present values over a five-year program period, allowing for gradual ridership growth from the beginning of the program and incorporating both start-up and ongoing costs. (In the absence of better information, we adopt the rather generous benefit estimates presented in the previous section.) These calculations, described in detail in Appendix B, produce the assessment measures shown in table H1.4. With respect to generating user benefits, the program appears to be so cost-effective that it is tempting to suggest that the users might be willing to support the program themselves, possibly through some kind of subscription fee.

Table H1.4: SUMMARY ASSESSMENT FOR THE AEROSPACE/SAMSO RIDESHARING PROGRAM

Eligible users	6,000
Program characteristics (annual)	
One-way trips served	435,900
Program cost	$11,000
VMT reduced	3,880,000
User benefits	$320,100
Performance Measures	
Program cost per VMT reduced	0.3 cents
Program cost per dollar of user benefit	3 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

For a private or public agency considering such a program, the relevant alternatives might be dedication of all the program funding to conventional transit, or changing the mix of the funding between car- and vanpools. Suppose the agency wished to achieved the 20,500 daily VMT reduction of the current program using conventional bus service with an average occupancy of 30 persons per bus. Starting with the September 1973 modal shares, and assuming that a bus is the equivalent of three cars for VMT purposes, it can be shown that 27 buses would be required to carry the 810 former private automobile drivers daily. To be as cost-effective as the current program, the service would have to operate at rather unrealistic subsidies of about three cents per one-way ride. The current program would therefore appear to be greatly superior to an all-transit program. Shifts of funding between car- and vanpooling would represent fairly minor modifications to the program, and would have to be evaluated at a quite detailed level.

References

Bush, L. R. (1974). "Response to Carpool Matching Programs - A Case Study." El Segundo, Cal.: The Aerospace Corporation (also reprinted by the Federal Highway Administration, US Department of Transportation).

Schnitt, A. (1980). "Descriptive Summary of Bus Express Employee Program: A Demonstration of Employment Center Bus Service." Report No. UMTA-CA-06-0109-80-1. Washington, DC: US Department of Transportation.

Case Study H2: The El Segundo Bus Express Employee Program (BEEP)

The El Segundo Employment Center contains a cluster of five large aerospace companies employing over 18,000 workers. Located near the Los Angeles International Airport, the center has good freeway access and free parking dispersed over an area of approximately two square miles. In 1973 a group of transportation specialists at The Aerospace Corporation located within the center began to implement various commuter travel options including carpools, vanpools, and subscription buses/1/. Based upon this experience, these specialists developed a new commuter bus service which was to have premium service characteristics and achieve higher productivity than conventional suscription buses by scheduling multiple bus runs during each workshift/2/. The regional transit authority, the Southern California Rapid Transit District (SCRTD), implemented an UMTA-sponsored demonstration project to examine the viability of this new type of bus service.

After six months of planning activities, in June 1978 the new bus service, termed BEEP (Bus Express Employee Program), began serving three companies at the center along seven routes. Major features of the express service included:

- schedules matched to working hours;
- routes and stops revised to meet changing commuter needs and conditions;
- ticket books and distance-based fares;
- new 51-seat buses; and
- route lengths varying from about 6 to 21 miles, with a mean length of 12.4 miles.

Ridership developed slowly during the first ten months, remaining below 200 boardings per day. By the Spring of 1979, however, ridership grew dramatically to over 900 boardings per day in response to acute gasoline shortages and a restructuring of routes to serve two additional companies. Ridership apparently reached a steady state by October 1979, and in the first half of 1980 daily ridership averaged about 800 passengers, roughly 50 percent of the scheduled seating capacity/3/. About 70 percent of the BEEP users previously drove alone to work.

Although BEEP was an express service with limited residential stops, overall average bus speed was only about 20 mph. A comparison of the route times and collection/distribution times indicates that on average collection and distribution amounted to 25 percent of route time, ranging up to 52 percent for the short routes, those less than seven miles.

/1/ See Case study H1.
/2/ Schnitt & Bush (1976).
/3/ Schnitt (1980), pp. 6-9.

Benefits

The VMT reductions attributable to the BEEP express bus service in 1980 averaged about 5,300 miles per day (table H2.1). The average daily ridership in 1980 was about 800 passengers, resulting in approximately 300 fewer automobiles used for commuting (about 2 percent of the total number of commute vehicles at the center). The decline in cars at the site helped reduce both peak hour congestion and the demand for parking space. Some secondary benefits also accrued to family members or friends who could use cars left at home during the day.

Table H2.1: DAILY VMT IMPACTS FROM BEEP SERVICE (1980)

	Number of Commuters Shifted	Average Vehicle Occupancy	Average Vehicle Round-Trip (Miles)*	Daily VMT Impact
Shifts from automobile to bus	400	1.3	20	-5,300

Note: * BEEP buses collectively travel about 830 miles daily.

Source: Daetz and Koltin (1981)

Table H2.2 uses the data in the previous table to estimate the net annual VMT impact of the BEEP service over a five-year period. It assumes an initial six-month period of linear growth from zero to the final stable levels shown in table H2.1. We assume that 15 percent of the households of BEEP users travel an extra 4 miles per day, offsetting the daily commuter VMT savings by 240, about 5 percent.

The user benefits can be estimated by taking one-half of the difference between the total user costs of all BEEP users driving to work alone and the total user cost of traveling by BEEP. Both user benefits and the VMT savings are presented for a five year program period in table H2.3.

Table H2.2 BEEP VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	Commuter VMT Reduction	Additional Household Travel	Net Annual VMT Reduction	Present Value
Year 1	1.00	-0.04	0.95	0.95
Year 2	1.33	-0.06	1.27	1.15
Year 3	1.33	-0.06	1.27	1.05
Year 4	1.33	-0.06	1.27	0.95
Year 5	1.33	-0.06	1.27	0.87
Total				4.98
Mean per year				1.00

Note: All entries are in millions of miles. The exhibit assumes 250 work days per year.

Costs and cost-effectiveness

Detailed cost data are available on the start-up, operating, and capital costs over the two-year demonstration period/4/. During the first year, the operating costs were $340,000 and marketing costs were about $12,000, both measured in 1980 dollars. Start-up and marketing costs in 1980 dollars together would be about $111,000. The capital costs for the ten buses (which have an estimated economic life of 12 years) would be about $78,000 per year in 1980 dollars. These estimates can be used together with the 1980 fare of $0.50 to develop the program costs and cost-effectiveness measures shown in table H2.3.

Alternatives

Numerous alternatives to the BEEP program can be devised. The basic elements of the express bus service concept probably could be modified to reduce operating costs and increase productivity. For example, private operators with 20-30 passenger buses could be used to provide the service at substantially lower costs. Private bus operators already serve the longer trips (more than 25 miles) at the center without public subsidy. Companies at the center also have carpool and vanpool programs that could be expanded at relatively low costs.

/4/ Daetz & Koltin (1981).

Table H2.3: SUMMARY ASSESSMENT FOR BEEP EXPRESS BUS SERVICE

Eligible users	18,000
Program characteristics (annual)	
One-way trips served	156,000
Program cost	$294,700
VMT reduced	996,000
User benefits	$87,800
Performance measures	
Program cost per VMT reduced	30 cents
Program cost per dollar of user benefit	$3.36

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-yera program period.

References

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Schnitt, A. (1980). "Descriptive Summary of Bus Express Employee Program: A Demonstration of Employment Center Bus Service." Report No. UMTA-CA-06-0109-80-1. Washington, DC: US Department of Transportation.

Schnitt, A. and Bush, L. R. (1976). "Feasibility Study of the Employment Center Bus Service Concept." NTIS Report PB 259941. Washington, DC: US Department of Transportation.

Case Study H3: The Minneapolis Ridesharing Program

The Minneapolis ridesharing program involved 11 multi-employer sites (with a total employment of about 70,000) outside the downtowns of Minneapolis and St. Paul. The sites ranged in size from 3,700 to 14,000 employees, each with numerous small firms clustered about one or more larger companies. The firms' activities included manufacturing, sales and service, office work, a hospital and warehousing. Like typical suburban locations elsewhere, these worksites have little traffic congestion, free parking, and limited transit service.

In July 1977, the regional transit authority, the Metropolitan Transit Commission (MTC), implemented a comprehensive ridesharing program to increase work trip vehicle occupancy at non-downtown locations. Using UMTA and state demonstration funding and a Federal Aid Urban Systems grant, the Share-A-Ride (as it is known) program was designed to be a permanent, on-going operation, characterized by:

- intensive marketing efforts aimed at employers and employees;
- manual matching services for carpool, vanpool, and bus rider applicants;
- follow-up assistance with carpool and vanpool information; and
- use of a third-party provider to supply and administer the van operation.

The program also promoted both regular and subscription MTC bus service as an integral part of ridesharing. During the first year, however, the subscription option (a chartered, unsubsidized MTC bus) was dropped because it became apparent that the monthly fares were high and potential buspool groups (with a minimum size of 30 persons) could not be formed. Also during the first year, it became clear that direct marketing efforts aimed at the smaller firms (those with fewer than 100 workers) were quite ineffective. Consequently, marketing in the second year was concentrated on larger firms.

During the first three years the decentralized organization of the program featured separate offices and staffs for central management, initial site marketing, continued marketing and carpool matching, and vanpool matching and operations. While this decentralization provided some flexibility and opportunities for public/private partnerships, it created some coordination and marketing difficulties. In response to these problems, alternative arrangements involving the MTC and various private organizations were considered. Although the various activities (except for the vanpool contractor) were consolidated in 1980 into a single MTC office, the appropriate roles of the public and private sectors in promoting and operating ridesharing has remained a major issue in the Twin Cities/1/.

During the first twelve months of full operation (starting November

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/1/ Weisbrod & Eder (1980), pp. 3-29 to 3-32.

1977), Share-A-Ride operated at three sites. By the end of 1979, the program had covered eight additional sites. Overall, after about two years the program had placed over 1200 employees into carpools and over 670 into vanpools. In the first year only about 400 carpoolers and 100 vanpoolers were involved. In the second year, however, the number of new rideshares increased substantially. This increase was due to the expansion of the number of sites and more focussed marketing efforts, and to the fortuitous influences of the dramatic gasoline price increase and supply shortages of April and May 1979. Significant variations in new ridesharing existed among the sites reflecting numerous factors such as the different employee and site characteristics, marketing efforts, timing, and employer support. Substantial information was obtained describing these factors/2/.

The overall impacts of Share-A-Ride on commuting mode choices was relatively small -- the drive-alone shares (as monitored at four of the sites) declined on average about two percentage points (ranging from 1.4 to 3.2 percent). The former modes of the new carpoolers and vanpoolers are shown in table H3.1.

Table H3.1: FORMER MODES USED BY NEW RIDESHARERS

	New mode	
	carpool	vanpool
Former mode		
drive-alone	95%	27%
carpool	--	65
bus	5	8

Source: Weisbrod & Eder (1980)

A unique aspect of the program, termed "telephone brokerage", involved making follow-up telephone calls to each matched carpool applicant. These calls helped to promote the program, encourage subsequent contacts, and provide feedback on problems at some of the sites. Unfortunately, not enough data exist to determine whether the number of additional applicants placed in pools was worth the considerable staff time required for the follow-up calls.

/2/ Weisbrod & Eder (1981).

Benefits

The VMT reductions attributable to the Share-A-Ride program after two years of activity averaged about 28,000 miles per day (table H3.2). This estimate reflects the fact that 65 percent of the new vanpoolers formerly carpooled and that some 5 to 8 percent of the new ridesharers previously rode buses. The total number of new ridesharers, about 1,230 carpoolers and 670 vanpoolers, resulted in about 890 fewer automobiles used for commuting (less than one percent of the total number of commuter vehicles at the eleven worksites).

Table H3.2: VMT IMPACTS OF SHARE-A-RIDE AFTER TWO YEARS

	Average Vehicle Occupancy*	Average Vehicle Round-Trip* (Miles)	Number of Commuters Shifted*	Daily VMT Impact+
Shorter trips:				
drive-alone	1.0	28	-1,172	-32,800
carpool	2.6	31	1,172	+14,000
Longer trips:				
drive-alone	1.0	54	-182	- 9,800
carpool	2.6	54	-437	- 4,500#
vanpool	11.0	68	+619	+ 5,400
Total VMT change				-27,900

Notes: * These data were derived from the source document.
+ A van is considered equivalent to 1.4 cars for VMT purposes.
# This estimate assumes that a half of the previous carpools continued to be operated by residual members.

Source: Weisbrod & Eder (1980)

Table H3.3 uses the data from the previous table to estimate the net annual VMT impact of the Share-A-Ride program over a five-year period. It assumes that during the first twelve months ridesharing grows from zero to one half the stable value shown in table H3.2, and that by the end of the second year the stable value is reached. We also assume that 15 percent of the households of new ridesharers travel an extra 4 miles per day, offsetting the daily commuter VMT savings by 1,070, about 4 percent.

The user benefits can be estimated by taking one-half of the difference between the total user costs of all the new Share-A-Ride carpoolers and vanpoolers driving to work alone (at 20.5 cents per mile) and the total user costs of traveling by either carpool (at 8 cents per mile) or by vanpool (a $40.65 monthly fare for a 65 mile trip daily equals about 3 cents per mile). Both the user benefits and the VMT savings over a five year period are shown in table H3.4.

Table H3.3: SHARE-A-RIDE VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	Commuter VMT Reductions	Additional Household Travel	Net Annual VMT Reduction	Present Value
Year 1	1.74	-0.07	1.67	1.67
Year 2	5.22	-0.20	5.02	4.56
Year 3	6.96	-0.27	6.69	5.53
Year 4	6.96	-0.27	6.69	5.02
Year 5	6.96	-0.27	6.69	4.57
Total				21.35
Mean per year				4.27

Notes: All entries are in millions of miles. We assume 250 work days per year.

Costs and cost-effectiveness

Cost data on the program for the demonstration period from June 1977 through 1979 are available/3/. However, the start-up costs for the various planning activities that began in July 1976 are not documented. During calendar year 1978 a breakdown of expenditures showed that marketing activities represented 35 percent, operations 37 percent, administration 21 percent, and planning and monitoring 7 percent of the total.

In 1980 dollars, the first year costs were $130,000; in the second year, $350,000 (excluding costs related directly to demonstration evaluation assistance); and in the third year $385,000. Since the initial site marketing costs can be expected to decline in subsequent years, the on-going costs can

/3/Weisbrod & Eder (1980).

be assumed to be about $300,000 per year. These estimates can be used to develop the program costs and cost-effectiveness measures over a five year period, as summarized in table H3.4.

Table H3.4: SUMMARY ASSESSMENT FOR THE MINNEAPOLIS RIDESHARING PROGRAM

Eligible users	70,000
Program characteristics (annual)	
One-way trips served	608,760
Program cost	$239,300
VMT reduced	4,270,000
User benefits	$309,600
Performance measures	
Program cost per VMT reduced	5.6 cents
Program cost per dollar of user benefit	77 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

The relevant alternatives to the Minneapolis Share-A-Ride program include different marketing activities and other organizational arrangements. After the first year, the program concentrated on larger employers and found that a multi-employer promotion works well only when it is "anchored" by one or more large (over 1,000 employees) firms. Since the more labor-intensive marketing activities, such as the employee presentations and the telephone brokerage follow-up calls, did not appear to be clearly cost-effective, these approaches should probably not be tried at new sites.

During the third year of the program the MTC centralized all of the marketing functions under a new program manager at one location, but continued to contract for the vanpool operations. In the follwing year additional organizational changes were made by the state department of transportation as part of a statewide program. These changes included having the MTC provide ridesharing services in the eastern half of the Twin Cities area and contracting with a private contractor (Van Pool Services, Inc.) for services in the western half. While it is difficult to assess the impacts of

organizational roles and relationships, they obviously affect program effectiveness. Other ridesharing programs should consider carefully the role of a public transit agency and the involvement of private contractors.

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Case Study H4: The Golden Gate Bridge Vanpool Program

The Golden Gate Bridge, Highway and Transportation District (GGBHTD) operates a unique set of transportation facilities and services that provide daily access to San Francisco for about 40,000 commuters from suburban Marin and Sonoma Counties. During the 1970s, rush hour traffic increased steadily across the six-lane Golden Gate Bridge, and the District implemented several strategies to mitigate congestion delays in the corridor by providing commuters alternatives to driving. In 1970 the District expanded its responsibilities for bridge operations by using toll revenues to subsidize ferry service and (in 1972) subscription and express bus services. In 1974, an exclusive lane for high-occupancy vehicles was introduced, with a 3.7 mile concurrent flow lane southbound in the morning and a 7.7 mile lane (part contra-flow and part concurrent flow) northbound in the evening. Since April 1976, car pools with three or more occupants have been exempt from paying tolls between 6:00 a.m. and 10:00 a.m. on weekdays.

In November 1977 automobile tolls on the bridge and bus fares in the corridor were increased to cover growing deficits of the bus operations. In addition, a decision was taken by the District that additional peak period transit service would not be provided because of the high deficits. (In 1979 the subsidy per person trip was estimated to be about $0.94 for Marin commuters and $1.67 for Sonoma riders.) As an alternative to expanding peak period transit service, the District implemented an UMTA-sponsored vanpool demonstration designed to test the viability of starting numerous privately owned vanpools with 35 District owned "seed" vehicles. The District marketed the vanpool concept and facilitated the formation of vanpool groups. The primary objective was to reduce the commuter vehicle volumes on the bridge without expanding the heavily subsidized transit services.

During the initial two or three years of the project, establishing the privately owned vans proved rather costly even though the vehicle and operating costs were covered by the fares. The administrative costs were estimted to be about $1.15 per person trip per day in 1979. However, as more privately owned vans are formed and as the administrative staff is decreased, the administrative costs are expected to decline significantly. An additional cost to this program arises from the fact that the District loses peak period toll revenues whenever single drivers or two-person carpools switch to higher occupancy modes. The average user cost per one-way trip by van is $0.96, and the average one-way trip length was 37.5 miles, giving a per passenger trip mile cost of 2.6 cents.

Since 1974 the percentage of the total commuters who are single drivers and carpoolers has remained almost constant at 72 percent, although the total number of commuters has increased 14 percent from about 35,000 in 1974 to 41,000 in 1979, as shown in table H4.1. During this period the average automobile occupancy increased from 1.31 persons to 1.36, and the approximate number of automobiles increased from 19,000 to slightly over 21,000. A two-month transit strike in April 1976 resulted in a dramatic shift to carpools and an increase in the automobile occupancy rate to about 1.5. After the strike many of the carpools continued amd transit ridership was slow to recover.

Table H4.1: MORNING PEAK MODAL SHARES ON THE GOLDEN GATE BRIDGE

	1974	1975	April 1976	October 1976	1977	Est. 1978/79
Average daily person trips (thousands)	35	36	37	38	39	41
Percent traveling by:						
drive-alone	39	40	44	41	40	39
2 person carpool	23	23	29	20	21	19
3+ person carpool	9	9	25	11	12	13
vanpool	-	-	-	-	-	1
transit bus	26	26	-	24	23	23
ferry boat	3	2	2	4	4	5
Approximate daily car trips (thousands)	19.0	19.6	24.1	20.6	21.2	21.4

Note: The data are for southbound traffic (towards San Francisco) in the period from 6 a.m. to 10 a.m.

Sources: Shellenberger (1978); Golden Gate Bridge, Highway & Transit District (1979)

The attractive combination of high-quality transit, subscription bus, ferry, van, and carpool services has enabled the District to accommodate over 6,000 new commuters since 1974 with only 2,400 additional automobiles. Without the District transit and ridesharing programs, more of these new commuters undoubtedly would have driven alone and caused greater congestion delays and VMT than have been experienced. Of course, the availability of the program may encourage some commuters to locate further from San Francisco than they might have otherwise done, an impact which offsets some of the VMT savings. Although an assessment of all of the costs and benefits of this comprensive program is beyond the scope of this evaluation, the vanpool element of the program can be assessed by using the results of a study conducted in 1979 by District staff.

The forecasts developed in the District study indicate that by 1983 an expected net reduction of 670 automobiles (about 3 percent of the projected volume without a van program) would result from a five-year expenditure of $834,000 in current dollars (table H4.2). During 1983 the van program costs for administration and marketing will amount to $0.22 per person trip, which compares quite favorably with the projected transit subsidies of $1.19 to $2.08 per person trip (table H4.3).

Table H4.2: PROJECTED FIVE-YEAR VANPOOL PROGRAM IMPACTS IN THE MORNING PEAK

	Fiscal Year				
	78/79	79/80	80/81	81/82	82/83
Daily vanpool users:					
GGBHTD vans	320	370	260	260	260
private vans	120	270	530	680	830
all vans	440	640	790	940	1,090
Daily vehicle flows:					
cars in absence of van pool program (thousands)	21.8	22.6	23.4	24.2	25.0
cars removed by the program	324	464	569	674	779
vans added	44	64	79	94	109
Annual toll revenue loss ($k, current)	75	109	132	156	179

Source: Golden Gate Bridge, Highway, and Transportation District (1979)

Table H4.3: VAN PROGRAM COSTS AND TRANSIT SUBSIDY PROJECTIONS

	Fiscal Year				
	78/79	79/80	80/81	81/82	82/83
Annual van program cost ($k, current)	228	275	102	110	119
Subsidy per person trip ($ current):					
GGBHTD vans only	1.43	1.49	0.78	0.83	0.92
all vans	1.04	0.86	0.26	0.23	0.22
Marin/SF Transit	0.94	1.06	1.19	1.19	1.19
Sonoma/SF Transit	1.67	1.87	2.08	2.08	2.08

Source: Golden Gate Bridge, Highway, and Transportation District (1979)

Benefits

There is considerable uncertainty in appraising the VMT impacts of the vanpool program because it is difficult to predict the number of van users and their alternative modes and trip lengths. The District staff assumed that all of the van users would come from single-occupant automobiles and carpools. This may be optimistic considering that during the first year of the demonstration about 65 percent of the van users were former transit riders and only 15 percent were former single drivers/1/. However, since the bus system is operating at close to capacity with no expansion planned, it is plausible that there will continue to be a demand by single drivers for bus seats vacated by van users/2/. Currently vans are serving quite long trips, but in the future they could be more attractive to automobile users with shorter trip lengths. Such a change in trip lengths would reduce the VMT savings estimated in table H4.4.

Table H4.4: DAILY VMT IMPACTS FROM GGBHTD VANPOOL PROGRAM (FY78/79)

	Number of Commuters Shifted	Average Vehicle Occupancy	Average Vehicle Round-Trip (Miles)	Daily VMT Impact*
Means of travel:				
automobile	-440	1.36	75	-24,300
van	+440	10.0	80	+ 4,900
Total VMT change				-19,300

Note: * A van is considered equivalent to 1.4 cars for VMT purposes.

Source: Golden Gate Bridge, Highway, and Transportation District (1979)

Table H4.5 estimates the VMT impact from the GGBHTD program over a five-year program period, based on the agency's projections for van usage. Offsetting household use of the automobiles left at home is calculated by assuming that 15 percent of the households use the cars for an additional 4 miles per day. Projected VMT reductions for the second through fifth years have been discounted using a 10 percent annual rate.

/1/ Dorosin, Fitzgerald, & Richard (1979).
/2/ By the second year, about 32 percent of the van users were former transit riders and 31 percent were former single drivers. See Dorosin (1982) for the complete results of the vanpool demonstration project.

Table H4.5: GGBHTD VANPOOL VMT IMPACTS OVER A FIVE-YEAR PROGRAM

	Commuter VMT Reduction	Additional Household Travel	Net Annual VMT Reduction	Present Value
Year 1	4.83	0.05	4.79	4.79
Year 2	7.03	0.07	6.96	6.33
Year 3	8.68	0.09	8.59	7.10
Year 4	10.33	0.10	10.22	7.68
Year 5	11.98	0.12	11.86	8.10
Total				33.99
Mean per year				6.80

Note: All entries are in millions of miles. We assume 250 work days per year.

Following the rationale of Appendix C, the user benefits of the program can be estimated by taking one-half of the difference between the total user costs of driving alone (including tolls and parking) and the total user costs of traveling by van. Table H4.6 summarizes both VMT reductions and user benefits for the GGBHTD program over a five-year program period.

Cost and cost-effectiveness

Some detailed data are available on the start-up and administrative costs through June 1978, about a year after the demonstration project began/3/. Since this was a demonstration, some of the staff, data collection, and other costs would not be necessary for other projects, though no estimates of these special costs are available at present. For the District, the automobile toll revenues forgone would also be considered costs of the program.

During the first year of the project, FY 77/78, we estimate that $60,000 was spent for marketing and $100,000 was spent for administration. These start-up costs in 1980 dollars would be about $191,500. As detailed in Appendix B, such estimtes can be used to develop cost-effectiveness measures for a five-year program period. The results, summarized in table H4.6, show that GGBHTD program is highly cost-effective for generating user benefits.

/3/ Dorosin, Fitzgerald, & Richard (1979).

Table H4.6: SUMMARY ASSESSMENT FOR THE GGBHTD VANPOOL PROGRAM

Eligible users	
Program characteristics (annual)	45,000
One-way trips served	312,500
Program cost	$264,300
VMT reduced	6,800,000
User benefits	$1,079,800
Performance Measures	
Program cost per VMT reduced	3.9 cents
Program cost per dollar of user benefit	24 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

The District considered two major alternatives to the van program: providing more express bus services and subsidizing more subscription buses. It was concluded, however, that subsidy costs per person trip by van would be substantially lower than for either of the bus options. (We estimate that the best opportunity for using more express bus services to reduce VMT would have a cost-effectiveness of between 10 and 15 cents per VMT reduced, significantly inferior to the van program). In 1981, the District also completed another demonstration project to test the feasibility of organized hitchhiking or "flexible ridesharing"/4/.

In 1977 the GGBHTD considered several toll and transit fare changes including a variable toll structure that would charge one- and two-occupant cars $2.00 while carpools would be free during the peak period. Since traffic congestion and other detrimental effects of automobiles are of major concern,

/4/ Dorosin (1981).

the District also could consider congestion pricing as a way of achieving more efficient use of the bridge/5/. Under such a scheme the tolls probably should vary by time period within the commuting hours in order to reflect the effect of traffic volumes and travel times. Apparently, no detailed study of such toll options has been carried out by the District to date.

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/5/ Kulash (1974); Bhatt (1976).

Case Study H5: Seattle's Flexible Work Hours Promotion Program

In addition to innovative service approaches to managing home-to-work travel demand, Seattle's Commuter Pool has adopted innovative operational approaches such as encouraging and helping area employers to implement flexible work hours. Commuter Pool, a comprehensive public ridesharing agency serving King County (Washington), concluded that it should complement its efforts to shift peak demands to high-occupancy vehicle use with efforts to shift commuter travel to less congested times of the day. Since the narrow range of work arrival and departure times was perceived as the root of the peaking problem, Commuter Pool decided to conduct an analysis of alternative work schedules. As a result of this 1977 study, Commuter Pool began a program to promote the adoption of flexible work hours (or flex-time) by downtown and suburban employers. Flexible work hours included any "system of varying work hours in which the employees themselves are given some degree of responsibility -- and choice -- for their own starting and quitting times"/1/. The major components of the promotional program involved marketing flex-time to chief executive officers of the area's largest employers, producing public service spots for television, developing resource materials, and providing on-site consultation to employers.

By 1979, Commuter Pool had convinced about 25 area workplaces -- mostly financial, insurance, governmental (federal), and high-tech manufacturing -- to convert to flex-time. In downtown Seattle, approximately 20,000 employees were participating in some sort of flex-time program ranging from "modified flex" (which requires employees to set their work hours in advance on a quarterly or monthly basis) to "full flex" (allowing employees to vary their hours from day-to-day without formal advance notice). According to surveys at eight worksites, employees made pronounced shifts to earlier schedules with the introduction of flexible work hours/2/. The percent of workers arriving to work before 7:30 a.m. increased from 23 percent to 54 percent, and the percent of workers leaving work after 4:30 p.m. dropped from 68 percent to 36 percent. The changes in home-to-work travel modes also were significant (table H5.1). The drive-alone share fell from 24 percent to 14 percent. The ridesharing and transit shares benefitted almost equally from the decline in solo driving; the percent of poolers rose to 23 (from 19) and the percent of transit users to 62 (from 56). The high gasoline prices and limited gasoline availability during parts of 1979 probably was a major influence in motivating these shifts. All of the surveyed flex-timers who changed from driving alone to transit identified "saving money on gas" as the most important reason, as did 68 percent of the drive-alones who switched to sharing a ride.

/1/ See Seattle/King County Commuter Pool (1980) for the many variations on the flex-time idea. Staggered work hours and compressed work weeks are not considered flexible work hours.
/2/ See Harrison (1980) for CBD worksite results and Jones & Harrison (1982) for suburban employer results.

Table H5.1: MODAL SHARES AT EIGHT SEATTLE CBD WORKPLACES

	proportion of employees	
	before flex time	after flex-time
Mode of travel:		
drive-alone	24%	14%
bus transit	56	62
carpool, vanpool	19	23
other (including walking)	1	1

Source: Harrison (1980)

Benefits

The VMT reductions achieved by the program were significant (table H5.2). Assuming that the flex-time promotion program was responsible for the entire 10 percentage point decrease in driving alone and that all of the new ridesharers and transit users drove alone before, the program reduced the total number of miles travelled each day by about 21,000 and the total number of automobiles used in commuting by about 1,600.

One of the major program benefits was reduced home-to-work travel time for all participants. For example, 18 percent of flex-timers working downtown reported saving more than 15 minutes on their one-way commute time and another 12 percent reported saving between 11 and 15 minutes/3/. People who switched travel modes after the program, as well as those who continued to commute as before, could save time by avoiding congested time periods. Unfortunately, these travel time savings cannot be quantified with the available data.

Table H5.3 shows VMT and user benefits for those switching to ridesharing and transit over a five-year period. The table assumes that program participation grew to 10,000 by the end of the first year and to 20,000 at the end of the second year, and then stabilized at that level. The user benefits for those deciding to rideshare or use transit can be estimated by taking one-half of the difference between the total user costs for employees driving to work alone (20.5 cents per mile in 1980) and the total user costs of ridesharing or using transit (an assumed value of about 9 cents per mile).

/3/ Harrison (1980).

Table H5.2: VMT IMPACT OF THE SEATTLE FLEX-TIME PROGRAM

	average vehicle occupancy*	average vehicle round-trip (miles)	number of commuters shifted	daily VMT impact+
Mode of travel:				
drive-alone	1.0	14	-2,000	-28,000
bus transit	40	10	1,200	300
carpool, vanpool	2.2	18	800	6,500
Total VMT change				-21,200

Note: * Assumptions, since data are unavailable.
+ A bus is considered equivalent to 3.0 cars for VMT purposes.

Costs and cost-effectiveness

Little information is available on the actual costs of Seattle's flex-time promotion program. For a similar effort, we have assumed that during the first two years an agency would have to spend approximately $100,000 for administrative costs each year, and $75,000 in the first year and $35,000 in the second year for marketing costs (all costs in 1980 dollars). The costs of maintaining participation built up at the end of the second year are assumed to be negligible. The start-up costs for a flex-time promotion program are small, and past experience with implementation should make these costs minimal.

Employers will incur some costs in switching over to flexible work hours. These costs will vary depending upon the complexity of the timekeeping device used (ranging from a simple sign-in/sign-out sheet to special computerized time accumulators). Improvements in worker productivity may offset some or all of these costs.

Alternatives

Seattle's Commuter Pool could have promoted staggered work hours and/or compressed work weeks in addition to (or instead) of flexible work hours. Staggered work hours differ from flexible work hours in one major respect: with staggered work hours the employer generally assigns starting and quitting times which vary for different groups within the work site. Compressed work weeks differ in that the working hours on the days worked are fixed.

The impacts on travel and mode use of these types of fixed schedules differ from the effects due to flexible schedules. Unfortunately, little

empirical data have been assembled to quantify the differences/4/. The existing level of transit use and the amount of ridesharing at a particular worksite also will influence how fixed or flexible schedules affect commuter travel.

Table H5.3: SUMMARY ASSESSMENT FOR THE SEATTLE FLEX-TIME PROGRAM

Eligible users	20,000
Program characteristics (annual)	
One-way trips served	638,400
Program cost	$ 59,500
VMT reduced	3,160,000
User benefits	$ 181,700
Performance measures	
Program cost per VMT reduced	2 cents
Program cost per dollar of user benefit	33 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

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Case Study H6: Short Trip Van Service at 3M Center

Over 10,000 people work at the 3M Company headquarters located on 400 acres east of St. Paul, Minnesota. The center has good freeway access and free parking for about 8,000 vehicles. In 1973 3M pioneered the first employer-sponsored commuter van program. By 1978 over 1,200 employees daily were using 100 vans to commute an average of 25 miles each way. The van drivers are not paid, but they receive free transportation to and from work and can keep the fares from additional passengers after the first ten. The fares are based upon distance traveled, and cover both the operating and capital costs of the service.

In 1978 3M introduced a new van service with the aid of a demonstration grant from the Minnesota Department of Transportation. The aim of this demonstration was to determine if a paid-driver van service could be effective for short trips of less than 3 miles one-way. By taking advantage of staggered work hours, 3M hoped to operate three round-trips per van during each peak period. Such high driver and vehicle utilization implied that relatively low passenger fares ($13.00 per month) would cover the operating costs.

Service was started to two target areas containing high concentrations of white collar workers. Since 3M had only two official starting times, the plan for three trips per peak period assumed that workers would be permitted some flexibility around these times and would be willing to take advantage of that flexibility. While the flexibility was available, most workers preferred to conform to the two official times. Consequently, the original idea of three trips per peak period proved to be impracticable, and only two trips per peak period could be scheduled.

An average of about 35 riders used the vans each day, with ridership on the second trip less than half of the seating capacity. According to a user survey, over 70 percent of the riders previously drove alone to work and most of them experienced a significant increase in travel time: the average reported time almost doubled from 10 minutes to 19 minutes/1/.

Benefits

An estimate of the daily VMT change due to the van service in the first year is presented in table H6.1. The two vans have removed over 25 automobiles each day from the roads and parking areas surrounding 3M. Family members or friends can use the cars left at home. Note that the VMT estimate is affected by the fact that, because of garaging locations, the vans had a relatively large proportion of deadhead mileage. Over this first year, it appears that the program led to an increase in VMT.

/1/ Minnesota Department of Transportation (1980).

Table H6.1: 3M SHORT TRIP VAN PROGRAM, FIRST YEAR DAILY VMT EFFECT (1979)

	prior modal share (%)	number of commuters shifted	average vehicle round-trip per rider (miles)	daily VMT change
Vanpoolers, end of first year		35		+178*
Prior mode of travel:				
car driver	72	25.2	5.0	-126
car passenger	7	2.5	4.0+	- 10
formal carpool	14	4.9	-#	-
transit bus	7	2.5	-#	-
Total daily VMT change				+42

Note: * This estimate assumes that 60% of the van mileage is deadheading. A van is considered equivalent to 1.4 cars for VMT purposes.

\+ The drivers serving these passengers are assumed to have eliminated 2 round-trips per day to 3M.

\# All previous buses and carpools are assumed to continue to operate.

Table H6.2 uses the first year data from the previous table to estimate the net annual VMT impact of the van service over a five-year period. The table assumes that the first year ridership of 35 per day increases to 60 riders per day in the second year (using the same number of vans) and that 78 percent of the riders previously drove to work. We also assume that 15 percent of the households of van users travel an extra 4 miles per day, offsetting the daily commuter VMT savings by about 3,800 in the first year. The assumption of increased ridership in the second through fifth years of the program leads to estimates of modest net VMT reductions in those years.

The user benefits can be estimated by assuming an average daily round-trip for van users of 5 miles and taking one-half of the difference between the total user costs of van users driving alone (assuming 15 cents per passenger-mile since parking is free) and the total user costs for the commuter vans (given by the $13.00 per month fare). Both user benefits and the VMT savings are shown for a five-year program period in Table H6.3.

Table H6.2: 3M CENTER VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	commuter VMT reductions	additional household travel	net annual VMT reduction	present value
Year 1	-10,500	-3,800	-14,300	-14,300
Year 2	13,800	-6,500	7,300	6,600
Year 3	13,800	-6,500	7,300	6,000
Year 4	13,800	-6,500	7,300	5,500
Year 5	13,800	-6,500	7,300	5,000
Total				8,800
Mean per year				1,800

Note: The exhibit assumes 250 work days per week.

Costs and cost-effectiveness

Operating and capital cost data are available for the first year only. Two part-time drivers were paid $4.50 per hour, an annual total of $6,850 in 1979, or $7,672 in 1980 dollars. Fuel, oil, maintenance cost about $3,360 per year; insurance, taxes and licenses cost $538 per van per year; and vehicle depreciation charges were $1,500 per year per vehicle (all in 1980 dollars). These estimates can be used together with the user fare of $13.00 per month, to develop program costs and cost-effectiveness measures over a five-year program period, as shown in table H6.3.

Alternatives

Without much higher vehicle utilization, the user fares will not cover the direct operating costs. Since the user fares are quite high already on a per-mile basis (about 12 cents), retaining riders at increased fares will be difficult.

Attracting more ridership will also be difficult because the overall travel time may increase with more riders. On long trips, the passenger pick-up times do not add much to the total travel time. With very short trips, however, a collection time of only one or two minutes per passenger can add more than ten minutes to what normally would be less than a ten-minute trip by automobile. A better option may be to form several carpools among riders living near each other. Unless the obstacles to obtaining three round trips by the vans in each rush hour can be overcome, this application of the commuter van concept to short trips does not look very promising.

Table H6.3: SUMMARY ASSESSMENT FOR THE 3M SHORT TRIP VAN PROGRAM

Eligible users	850
Program characteristics (annual)	
One-way trips served	22,500
Program cost	$5,600
VMT reduced	1,800
User benefits	$700
Performance measures	
Program cost per VMT reduced	$3.18
Program cost per dollar of user benefits	$7.86

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips served and VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

References

Minnesota Department of Transportation (1980). "St Paul: Short Trip Commuter Van Service at 3M Center." Paratransit Demonstration Evaluation Report no. 10. St. Paul, Minn.: Minnesota Department of Transportation.

Case Study H7: The Sacramento Employer Transit Pass Discount Program

The Sacramento Regional Transit District (SRTD), serving most of Sacramento County (1976 population about 700,000), operates a primarily CBD-oriented system. Sacramento, the capital of California, has many governmental and service employers, and a few manufacturing companies. In 1977, the SRTD operated about 220 buses and carried about 45,000 trips per weekday. The regular cash fare was 35 cents, with monthly passes available at 35 sales outlets in the area for $12 (about a 14 percent discount for a daily commuter). In 1977 about 20 percent of all riders used monthly passes.

In 1978, the SRTD began an UMTA-funded demonstration aimed at enlisting employers to sell monthly bus passes directly to their workers/1/. By marketing passes through employers the SRTD hoped to increase community awareness of transit, broaden employer involvement, and increase transit ridership. The demonstration had four general phases:

- contacting employers to solicit their participation in selling passes to their workers;
- providing information and marketing materials to employers and their employees about the new pass program;
- distributing passes to employer locations for sale; and
- discounting the price of passes for a limited time to stimulate sales.

Beginning in March 1978, SRTD sent letters to the managers of about 140 of the estimated 180 major employers in its service area. After three months only ten firms had agreed to participate and over one hundred had refused. The uninterested employers cited such reasons as the belief that few of their workers used the bus and that their working hours did not match the bus service. To induce greater participation SRTD decided to offer a three-month 25 percent price discount for passes. In addition, SRTD redirected its promotional activities towards employees rather than company managers. The discount gave the employers an incentive because they would be offering their workers a more tangible benefit.

This new strategy induced over 40 more employers to join the program: by December 1978, a total of 52 firms were participating. Over half of the employers were public agencies. Due to the larger size of the government installations, over 80 percent of the eligible employees (about 49,000) worked in the public sector. The vast majority of firms sold passes over the counter and only one-seventh offered a payroll deduction option.

The employee response to the three-month 25 percent discount ($12 passes cost $9) was dramatic. The number of pass sales nearly tripled at some firms. Most of the purchasers previously bought passes at the public outlets (about 60 percent) or paid cash each day (about 30 percent). However, the

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/1/ Daetz & Holoszyc (1981).

total number of employees buying passes at any location rose over 80 percent. The rise in employer-sold passes increased the total monthly pass sales during the first month to 23 percent above the level expected on the basis of past trends. (Total pass sales had been growing at over 30 percent per year prior to the discount period.) Following the discount period, employer-pass sales immediately dropped by 50 percent. Three months after the end of the discount, the impact on total pass sales appeared to disappear.

Although almost all of the discounted, employer-sold passes were bought by previous transit users, an estimated 10 percent of the purchasers were new riders attracted by the discount. Based upon the number of passes sold in the third month of the discount, about 300 persons became new bus riders. Before the pass discount period, about 18 percent of the estimated 49,000 workers in the 52 firms used buses. The 300 new users would raise the bus share to 18.6 percent.

The new bus commuters appeared to be similar to current riders with respect to age, sex, household income and size, and workers in the household. They reported slightly lower automobile ownership, however. The new riders appeared to stop using transit after the discount period at about double (6 percent per month) the rate of the typical users (3 percent per month). However, eight months after the discount period, approximately sixty percent of the new users continued to ride.

According to surveys, merely using a monthly pass does not increase the likelihood of continuing to use transit beyond one month. The primary attraction of passes was the cost advantage relative to cash fares. Compared to the eligible employees and to the transit-using employees, those buying passes included proportionately more women and more lower-income persons.

<u>Benefits</u>

The VMT reductions attributable to the employer-sold passes and the 25 percent discount period cannot be estimated accurately with the available data. Although the employee survey data can be used to estimate how many commuters started riding buses, we have to make assumptions about the previous mode used and average trip lengths for these new riders. We estimate that the daily VMT reductions averaged about 1,300 in 1979 (table H7.1).

Table H7.2 uses the data from the previous table to estimate the net annual VMT reduction over a five-year period. The table assumes that the new riders attracted by the discount gradually drop out at the rate observed in the demonstration (that is, 40 percent will have stopped riding after 8 months, and all new riders will have stopped after 20 months). The surveys in Sacramento indicated a high turnover rate for commuter bus users in general, with about 30 percent of the riders being replaced each year. It is also assumed that 15% of the households of the people switching to bus each produce an extra 4 car miles per day.

The user benefits can be estimated by taking one-half of the difference between the total user costs for the new bus riders to drive to work alone and the total user costs of the monthly passes. Both user benefits and VMT savings are presented for a five-year program period in table H7.3.

Table H7.1: DAILY VMT REDUCTIONS FROM DISCOUNTED PASS SALES (1979)

	number of commuters shifted	average vehicle occupancy*	average round-trip (miles)*	daily VMT reduction
Shifts from automobile to bus	210+	1.3	8	1300

Notes: * Assumptions, since data are unavailable.

+ Based on survey results, only 60 percent of the 300 new riders continued to ride eight months after the discount period. The average number of riders over a twelve-month period would be about 210.

Table H7.2: SACRAMENTO PASS DISCOUNT VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	commuter VMT reduction	additional household travel	net annual VMT reduction	present value
Year 1	325,000	31,500	293,500	293,500
Year 2	61,800	6,000	55,800	50,700
Year 3	-	-	-	-
Year 4	-	-	-	-
Year 5	-	-	-	-
Total				344,200
Mean per year				68,800

Note: The exhibit assumes 250 work days per year.

Costs and cost-effectiveness

The experience with the start-up and ongoing costs over the 26-month demonstration period can be used to estimate the costs of a three-month, 25 percent pass discount program/2/. The only major costs were those to set up and administer the program. While the lost revenues from existing riders over the three months amounted to about $12,000, this loss was made up by the new users in about seven months. (We assume that the small increase in new riders did not affect the costs of providing SRTD peak hour services. If additional bus service has been required to accommodate the new users, these costs would have to be included.) The start-up activities required about six months and the discount period lasted three months. The start-up costs included management and clerical labor and benefits, pass materials, and public relations and advertising contracts. These costs were about $3,660 per month in 1979 dollars, or $4,200 per month in 1980 dollars. Throughout the demonstration period, SRTD incurred an average cost of about 11 cents per pass for all passes sold and about 5 cents for employer-sold passes. The approximate administrative costs reported by employers was about 50 cents per monthly pass. These data were used to develop the program cost and cost-effectiveness estimates given in table H7.3.

Table H7.3: SUMMARY ASSESSMENT FOR THE SACRAMENTO PASS DISCOUNT

Eligible users	49,000
Program characteristics (annual)	
One-way trips served	24,600
Program cost	$7,900
VMT reduced	68,800
User benefits	$12,300
Performance measures	
Program cost per VMT reduced	11 cents
Program cost per dollar of user benefits	64 cents

NOTE: Costs are expressed in 1980 dollars, and all costs and benefits (including trips served and VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

/2/ Daetz & Holoszyc (1981).

Alternatives

In Sacramento, it seems clear that the number of new riders attracted to transit solely on account of an employer pass program (in the absence of a significant price discount) would have been negligible. While this may have been due to the fact that a large share of the market for monthly passes had already been tapped (by a mature pass program in existence for five years with over 35 sales outlets), results from other demonstrations in Austin, Texas and Phoenix, Arizona also support this conclusion/3/.

Because a short-term price discount for monthly passes appears to induce a small number of new bus users at relatively low cost, transit operators could consider offering similar discounts every year or two as an ongoing marketing tool. (There was some resentment in Sacramento, however, among the regular transit riders who were not eligible for the discount.) The transit agency could also try to convince specific employers to offer transit pass subsidies for their workers on a short-term trial basis.

Perhaps a better approach than offering all workers discounted passes would be to target the reduced price passes to new employees or to families just moving into new residences. Discounted passes for a short-term could also be offered when new services are introduced. The added convenience of not paying by the trip together with an economic incentive would then be focused at potential users who may truly be considering a change of mode.

References

Bloomfield, P.; & Crain, J. (1979). "Transit Fare Prepayment Demonstrations in Austin, Texas and Phoenix, Arizona." Report no. UMTA-MA-06-0049-80-1. Cambridge, Mass.: US Department of Transportation, Transportation Systems Center.

Daetz, D.; & Holoszyc, M. (1981). "Sacramento Transit Fare Prepayment Demonstration." Report no. UMTA-CA-06-0102-80-1. Cambridge, Mass.: US Department of Transportation, Transportation Systems Center.

/3/ Bloomfield & Crain (1979).

Case Study H8: The Tennessee Valley Authority Ridersharing Program

The Tennessee Valley Authority (TVA), at its headquarters in downtown Knoxville, is the second largest employer in the city with over 3,400 personnel. Prior to 1974, TVA had been pressed to provide employee parking as a union benefit. When in the Spring of 1974 TVA decided to construct new downtown office facilities involving the elimination of about 1,300 surface parking spaces, various transportation proposals were considered for providing substitute services. Negotiations between TVA administrators and employee union representatives resulted in the development of a mass transportation incentive plan which included parking discounts for carpools, discounted fares on bus services, and a subsidized vanpool program.

The TVA program was implemented in January 1975, initially as a demonstration program. The program is administered by a transportation coordinator who assists employees in forming carpools and vanpools and helps negotiate bus service levels with bus operators. The carpool parking discount was available to carpools of three or more riders (at least two of whom had to be TVA employees) and consisted of a $5 monthly parking ticket for parking spaces located some six blocks from the TVA offices. For bus users, a one-third fare discount was provided which could be used on regular and express services. TVA also provided a revenue guarantee to bus operators for certain routes serving TVA employees. The vanpool program actually began in June 1974 when the transit agency informed TVA that there was little propsect of additional bus service for TVA employees. In 1975 TVA began to subsidize vanpool user fees by $3 to $11 per month depending upon trip lengths and the number of riders per van.

TVA employees have made substantial changes in their home-to-work travel modes since November 1973 (table H8.1). The level of carpooling previously had been quite high at 30 percent, and increased to just over 40 percent after the gasoline shortages and the initiation of the TVA program. Perhaps the most dramatic impact of the program is the growth in the level of express bus ridership to 28 percent of all trips. Vanpooling also has had a significant impact, and as of 1980 was still increasing its share of the market.

Benefits

Perhaps the most important benefit of the TVA program is that it has satisfied TVA's transportation obligations to its employees, and at substantially lower cost to TVA than realistic alternatives such as provision of additional parking spaces. It is this objective which appears to have been the driving force behind the program. As shown in table H8.2, TVA has been able to reduce the use of on-site parking spaces by half while employment has grown by over 15 percent, a quite remarkable accomplishment.

There also have been substantial VMT reductions as a result of the program, an impact which should be of considerable interest to public agencies trying to achieve such reductions. If the entire shift observed between November 1973 and January 1977 is attributed to the program, and if this impact is applied to the 1977 employment level of 3400, the daily VMT reduction with respect to commuter travel can be estimated as 29,906 as shown in table H8.3. If we assume that 15 percent of the households of TVA carpool, vanpool, and express bus users travel an extra 4 miles per day, the daily

commuter VMT savings shown in the table would be offset by 980, about 3 percent.

Table H8.1: MODAL SHARES AT TVA

	Nov 1973	Dec 1974	Jan 1975	Jan 1976	Jan 1977
Approximate total employment	2,950	3,000	3,100	3,200	3,400
<u>Percent traveling by:</u>					
drive alone	65.0%	42.0%	30.0%	19.0%	18.0%
carpool	30%	40.0	42.0	42.0	41.0
transit	3.5	3.0	5.0	3.0	3.0
express bus	-	11.0	18.0	28.0	28.0
vanpool	0.0	2.3	3.0	5.0	7.0
walk, bike, other	1.5	1.7	2.0	5.0	3.0

Table H8.2: TVA ON-SITE EMPLOYEE PARKING USE

	November 1973	December 1974	January 1975
Total employment	2,950	3,000	3,400
Number of motor vehicles	2,195	1,641	1,066

Source: Wegmann, Chatterjee & Stokey (1978)

For a company or public agency considering a program like TVA's, the expected VMT impact over a five-year program period is estimated in table H8.4. We have assumed that the commuter VMT reductions grow linearly during the first six months from zero to the final stable levels shown in table H8.3, and then stay at those levels for the remainder of the five-year period. The impact of additional household travel is included based on the daily estimate developed above. For the second through the fifth years, the net VMT reductions are discounted to present values using a 10 percent discount rate.

Exhibit H8.3: DAILY VMT REDUCTIONS FOR TVA COMMUTER TRAVEL (JANUARY 1977)

	number of commuters shifted	average vehicle occupancy	average vehicle round-trip (miles)	daily VMT impact*
Means of travel:				
drive-alone	-1598+	1.0	22	-35,200
carpool	+ 374	3.2	22	+ 2,600
express bus	+ 952	41.4	22	+ 1,500
vanpool	+ 238	13.2	46	+ 1,200
Total VMT change				-29,900

Note: * A bus is considered equivalent to 3.0 automobiles and a van equivalent to 1.4 automobiles for VMT purposes.

\+ Includes commuters shifted to modes not accounted for here (e.g., bicycle).

Source: Wegmann, Chatterjee, & Stokey (1978)

The net user benefits accruing to TVA commuters are not comparable to those obtained under the Aerospace/SAMSO program (Case Study H1), for example, because of the user benefits lost as a result of the elimination of the 1,300 parking spaces. If the TVA program had been implemented without the removal of the parking spaces, those employees who switched modes would certainly have benefited. It is interesting to speculate about how much of the TVA VMT reduction would have been achieved if the parking spaces had been retained. It is shown in Appendix C that the user benefits accruing to those who would have switched modes even if the parking spaces had been retained are partly offset by the loss of user benefits experienced by those who were "forced" to switch by the removal of the spaces. The TVA program also undoubtedly generated some secondary benefits which accrued to family members or friends who used a car left at home or who were relieved of driving a commuter to work.

Costs and cost-effectiveness

The only cost data readily available for the TVA program are shown in table H8.5. These data do not appear to include start-up managerial or ongoing TVA administrative costs. If we assume start-up costs of $11,200 and ongoing administrative costs of $16,800 per year (both in 1980 dollars), and ongoing subsidy costs of $153,000 in 1980 dollars, we can calculate present values of costs and benefits over a five-year program period, allowing for gradual ridership growth and incorporating all program costs. The overall results are presented in table H8.6. The cost per VMT reduced is substantially higher than for Aerospace/SAMSO, perhaps reflecting the fact that once

Table H8.4: TVA VMT REDUCTIONS OVER A FIVE-YEAR PROGRAM

	commuter VMT reduction	additional household travel	net annual VMT reduction	present value
Year 1	5.61	-0.18	5.43	5.43
Year 2	7.48	-0.24	7.24	6.58
Year 3	7.48	-0.24	7.24	5.98
Year 4	7.48	-0.24	7.24	5.12
Year 5	7.48	-0.24	7.24	4.94
Total				28.05
Mean per year				5.61

Note: All entries are in millions of miles. The exhibit assumes 250 work days per year.

the most "receptive" converts to mass transportation have been obtained, the costs of shifting additional private automobile users increase dramatically, even where there are significant restrictions on parking.

Table H8.5: ANNUAL COST OF THE TVA PROGRAM (1977 DOLLARS)

Cost elements:	
Carpool parking subsidy	$ 1,900
Express bus subsidy	74,700
Bus guarantees	10,200
Vanpool subsidy	27,000
Credit union administrative charge	11,200
Total costs	$125,000

Source: Wegmann, Chatterjee, & Stokey (1978)

Alternatives

The relevant alternatives to the current TVA program are probably restricted to changes in the funding and levels of effort devoted to the different mass transportation modes. The alternative of building additional parking spaces at four times the annual cost of the current program is probably not a worthy option at this point. TVA reportedly discontinued the carpool parking subsidy early in 1978 due to low participation, and concentrated its funding on express buses and vanpools. A detailed assessment of the effects of shifting TVA funds and effort between express bus, carpools, and vanpools is beyond the scope of this evaluation.

Table H8.6: SUMMARY ASSESSMENT FOR THE TVA RIDESHARING PROGRAM

Eligible users	3,400
Program characteristics (annual)	
One-way trips served	570,200
Program cost	$ 149,800
VMT reduced	5,610,000
User benefits	N.A.
Performance measures	
Program cost per VMT reduced	2.7 cents
Program cost per dollar of user benefit	N.A.

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

Reference

Wegmann, F. J.; Chatterjee, A.; & Stokey, S. R. (1978). "Evaluation of an Employer-Based Commuter Ride Sharing Program," in Urban Transport Service Innovations, Transportation Research Board Special Report 184. Washington, DC: Transportation Research Board.

Case Study H9: The Seattle Expansion of Peak Bus Services with Part-Time Operators

Seattle Metro serves metropolitan Seattle and portions of King County, Washington (1980 population 1,390,000). As one of the largest transit systems in the country, it received national attention in 1978 when it negotiated a labor contract allowing part-time drivers during peak hours. Since then a number of major transit systems have negotiated agreements to employ limited numbers of part-timers/1/.

After several years of dramatic ridership and cost increases, Metro management in 1977 decided that further patronage growth would be possible only if new cost control efforts, particularly regarding work rules, could be made. Since the off-peak market did not appear to be growing, Metro planned to reduce poorly patronized off-peak service and substantially increase the rush-hour service to attract new riders. Expanding peak period service under the existing labor contract, however, would have required paying new operators for eight hours each day even though they worked only a few hours. Management concluded that the most effective way to control operating costs and still expand rush hour service was to use part-time drivers. This case study documents the implementation of part-time drivers to expand peak hour service in Seattle and describes the cost and other impacts of part-timers/2/.

After four months of negotiations, an agreement which allowed part-time drivers only during peak hours under certain conditions was ratified by the Amalgamated Transit Union membership 725 to 606. While all of the factors contributing to any labor agreement cannot be identified, some apparent reason for this settlement are:

- Metro's intention not to reduce the full-time workforce.
- Metro's willingness to grant an acceptable wage and benefit package.
- Metro's willingness to take a strike, which derived from business community support and detailed contingency plans to mitigate a strike's impact.
- The union's lack of membership support for a long-lasting shutdown, and
- Metro's well-timed threat of legal action.

The new contract limited the number of part-time drivers who could be employed, as well as the amount and type of work they could perform. The key provisions were:

- part-time operators could only work "tripper" assignments (relatively short, about two hours) during peak hours;

/1/ Chomitz and Lave (1981).
/2/ Based upon Urbitran Associates, Inc. (1982), pp. VIII-1 to 29.

- the number of regular and "extra-board" operators would always exceed the number of tripper operators;

- certain work (such as charters and extra-board) would be reserved for full-timers;

- Metro could not alter or eliminate existing runs to provide more part-time work (only new service could be scheduled for part-timers);

- part-time drivers would be limited to one tripper assignment per day; and

- tripper operators would become union members.

The number of part-timers grew from 176 in 1978 to over 800 in early 1982, when they represented over 30 percent of the total number of operators. During this same time period, the number of tripper assignments increased substantially until it accounted for about one-half of the total weekday trip assignments. According to Metro records, the performance of part-timers as measured by absenteeism, accidents, passenger complaints, percent completing training, and turnover has generally been as good or better than that of full-timers.

Benefits

The major direct benefit of introducing the part-time drivers was the expansion of peak hour service at lower cost than would be possible with full-time drivers. From 1977 to 1981, the total hours of bus services increased over 33 percent (see Table H9.1). Almost all of this increase was in the peak hours. Although Metro proposed significant cuts in off-peak service (during evenings and on weekends), local political opposition resulted in only minor service reductions during non-rush hours.

Annual ridership grew from about 46 million linked passenger trips in 1977 to 66 million in 1981. The travel impacts ascribable to the peak hour service expansion, however, cannot be estimated because so many other changes affecting ridership occurred during the same years. Some of these changes included gasoline shortages and price increases in 1979-80, fare increases in 1979 and 1980, and general employment growth in the Seattle area.

Metro has developed a simple regression model based on eight years of historical data which can make quite accurate short-term monthly ridership projections/3/. The experience with this model, however, suggested no significant relationship between increasing total service hours and ridership. In fact, the employment, gasoline price and supply, and fare factors explained much of the ridership growth between 1977 and 1982 while the service hour variable was not significant. The staff member who developed the model commented that new service hours historically have been implemented in response to ridership growth rather than preceding it.

/3/ Ulberg (1982).

Table H9.1: ANNUAL PLATFORM HOURS 1977-81

Year	Hours (millions)	Percent Change From 1977
1977	1.805	--
1978	1.870	4
1979	2.022	12
1980	2.268	26
1981	2.427	34

Source: Seattle Metro

Costs and Cost-Effectiveness

Cost savings from using part-time drivers for the peak service expansion resulted from three factors:

- part-timers were not subject to the full-time driver work rules guaranteeing eight hours pay per day or providing for other premium pay;
- part-timers were not paid as much per hour because it took about three years to reach the regular pay scale step; and,
- part-timers received fewer benefits such as vacation pay, sick leave, and pension contributions.

Estimating the actual costs of using part-time rather than full-time drivers is rather complicated due to the interactions of work rule restrictions and the nature of bus service peaking. A detailed discussion of these interactions, together with methods for estimating the potential cost impacts of part-time labor, is found in Chomitz and Lave (1981).

The most accurate method to estimate cost impacts involves performing an actual schedule run-cut in accordance with the work rules and then costing-out the expected driver pay hours with and without part-time drivers. Metro, however, has not performed such a time-consuming exercise. For this case study we will take the cost saving figures reported in Urbitran (1983). These savings estimates appear to be derived from comparing the cost of two peak-hour trippers as a split run operated by a full-time driver to the cost of the same trippers operated by two part-time drivers/4/. The estimated cost savings during 1978-81 are shown in Table H9.2.

/4/ Other costs, of course, may have been affected. If management had to make other contract concessions (such as pay increases or new benefits for full-timers), then over time the part-time savings could disappear. Training and some administrative costs also may increase for part-timers.

Table H9.2: ESTIMATED SAVINGS FROM PART-TIME DRIVERS 1978-81

Year	Annual Savings ($ millions)	Percent of Total Driver Wage Costs
1978	0.8	4
1979	2.0	8
1980	3.8	8
1981	4.7	9

Source: Urbitran (1982)

If the peak hour expansions were made on a 1980 base year, the first year savings (in 1980 dollars) would be $1.02 million (inflating the 1978 estimated savings of $800,000). Similarly, the savings (in 1980 dollars) in the second through fifth years would be (in millions) $2.3, $3.8, $4.7, and $4.7, respectively. Taking the present values over a five-year program period produces the measure shown in Table H9.3/5/.

Table H9.3: SUMMARY ASSESSMENT FOR SEATTLE'S PEAK SERVICE EXPANSION USING PART-TIME DRIVERS

Eligible Users	
Metropolitan Workforce	520,000
Program Characteristics (annual)	
Costs Saved Per Year	$2,480,000

Note: Costs are expressed in 1980 dollars, and are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

To serve more travelers during the commuter rush hours, Metro management chose to negotiate the use of new part-time drivers to provide more service. Another option for reducing peak hour labor costs is negotiating to limit or decrease the hourly costs of the regular drivers. Such negotiations might

/5/ As discussed earlier, we cannot estimate the travel benefits ascribable to the increases in service hours. It also should be recognized that simply changing the supply of bus services does not necessarily generate positive traveler impacts.

address changing the wage rate and cost of living adjustments; reducing the eight hour guarantee; or altering the maximum spread time and premium pay provisions.

The savings from part-time operators, or most other work-rule changes depend upon both the context of the other work rules in a transit agency and the daily service profile. Because of this complexity, Chomitz and Lave (1981) concluded that experimental run-cutting is a potentially useful tool for transit negotiations. They suggest joint union-management run-cuts might be used to explore available trade-offs between spread premiums, guaranteed time, part-time labor, and other changes. More informed negotiations may be more likely to yield a better outcome than simple bargaining.

By encouraging greater use of ridesharing modes such as carpools, vanpools, and subscription buses it is possible to reduce the passenger demand for some peak hour transit service. Seattle's Commuter Pool, a comprehensive ridesharing agency, also has been successful in shifting commuter travel demand to less congested times by helping employers implement flexible work hours (see Case Study H5). A more radical option would involve contracting with lower cost private bus and cab companies to operate peak-period supplementary services rather than expanding the existing transit workforce and fleet. Metro currently does contract with four private bus companies to provide scheduled van service during peak and off-peak periods on nine routes in suburban areas.

References

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Chapter 4

SPECIAL USER GROUP TRAVEL EXAMPLES

A GUIDE TO EXAMPLE PROGRAMS

Programs directed at the special user group travel market -- travel by the elderly, the handicapped, the young, and the economically disadvantaged -- are considered in this chapter. A great deal of diversity exists in special user group programs with regard to the eligibility of users, the types of services which are subsidized, and administrative procedures for disbursing subsidy funds.

Exhibits 5 through 7 list a number of established programs in areas of different sizes. Detailed case studies for some of these -- those with identification numbers -- follow. As before, the cases reported with most methodological detail are identified with an asterisk. Exhibit 8 provides references for sources of more detailed information about the projects not selected for case study treatment.

Exhibit 5: SPECIAL USER GROUP TRAVEL EXAMPLES FOR LARGE URBAN AREAS

	example, and case study number	setting	service area population (thousands)	dial-a-ride service (except for transit)	provider arrangements
	Cleveland (Oh.)	3 inner-city neighborhoods	100	small busses & vans	transit agency
	Jacksonville (Fl.)	urban county	580	various	non-profit corp. coordination
	Miami (Fl.)	metropolitan county	150	taxis & special vans	county/private operators
S1.	Milwaukee (Wi.)	urban county	965	taxis & chaircars	user-side subsidy
	Oklahoma City (Ok.)	central city	580	taxicabs	user-side subsidy taxi operators
S2.	Pittsburgh, (Pa.)	region	1,850	various	transit authority & coordination organization
S3.*	Portland (Or.)	central city	385	special buses; taxicabs	transit authority taxi operators under contract
	Sacramento (Ca.)	various	265	various	nonprofit corp.
S4.*	Seattle (Wa.)	central city	1,200	wheelchair accessi-ible transit buses	transit authority

* Case studies developed in greatest methodological detail.

Exhibit 6: SPECIAL USER GROUP TRAVEL EXAMPLES FOR MEDIUM-SIZED AREAS

example, and case study number	setting	service area population (thousands)	dial-a-ride service (except for transit)	provider arrangements
Baton Rouge, (La.)	citywide	240	vans	transit operator
Fort Worth (Tx.)	citywide	390	various	transit authority, taxis, social service agencies
Grand Rapids (Mi.)	county	410	various	transit authority coordination
Lawrence (Ma.)	citywide	67	fixed-route transit, taxicabs	user-side subsidy, private bus, taxis
Montgomery (Al.)	citywide	133	fixed-route transit, taxicabs	transit authority, user-side subsidy taxi operators
Syracuse (NY)	citywide	200	special 10-pass buses	transit authority

Exhibit 7: SPECIAL USER GROUP TRAVEL EXAMPLES FOR RURAL & SMALL URBAN AREAS

example, and case study number	setting	service area population (thousands)	dial-a-ride service (except for transit)	provider arrangements
S5.* Danville (Il.)	isolated city	45	taxicabs	user-side subsidy, taxi operators
Fayetteville (Ar.)	four rural counties	170	various	administrative coordination
S6. Kinston (NC)	isolated city	22	taxicabs	user-side subsidy, taxicab operators
St. Cloud (Mn.)	isolated city	49	taxis, special buses	transit authority, taxi operator under contract

* Case studies developed in greatest methodological detail.

Exhibit 8: REFERENCES FOR EXAMPLES NOT USED AS CASE STUDIES

type of size	example	source of further information
LARGE URBAN	Cleveland (Oh.)	Crain (1977)
	Jacksonville (Fl.)	Burkhardt et al. (1979)
	Miami (Fl.)	Dade County (1977)
	Oklahoma City (Ok.)	Green (1978)
	Sacramento (Ca.)	Flynn (1981)
MEDIUM URBAN	Baton Rouge (La.)	McCall, Olson, & Reed (1976)
	Fort Worth (Tx.)	Cox & Rosenbloom (1977)
	Grand Rapids (Mi.)	Burkhardt et al. (1979)
	Lawrence (Ma.)	TSC Forthcoming
	Montgomery (Al.)	Nelson (1983)
	Syracuse (NY)	Przepiora et al. (1977)
RURAL & SMALL URBAN	Fayetteville (Ar.)	Burkhardt et al. (1979)
	St. Cloud (Mn.)	Minnesota Department of Transportation (1980a)

Case Study S1: Milwaukee's User-Side Subsidy Program for the Handicapped

In June 1978 Milwaukee County (1980 population 965,000) began a user-side subsidy program to provide door-to-door service for persons confined to wheelchairs. In November 1978 the program eligibility was expanded to include persons requiring walkers or crutches, and the blind. Eligible users can travel on any participating taxicab or chair-car company in the county (an area of 237 square miles). The program requires that users pay a minimum fee per trip of $1.00 (increased to $1.50 January 1981), and then subsidizes the remaining cost up to a maximum of $9.50 for wheelchair users and $6.50 for others.

Beginning primarily with state funds, by 1981 the program received over 60 percent county funding with no federal assistance. Due to the program's success in serving handicapped persons, the county entered into a conciliatory agreement with the individuals who had sued the county in 1976 over lift-equipped buses. The county transit system in 1982 agreed to stop operating the lifts on 250 buses (which had very low usage) and, instead, to fund this program at a level equal to 2.2 percent of the system's operating budget.

The administration of the program is relatively simple. Participants can register through the mail and be certified by a doctor or social service agency (certification forms are verified over the telephone). In early 1981, the program introduced an annual registration fee of $5.00 to help restrain the administrative costs of registration. When traveling, participants show the driver their program identification card and then complete a voucher (stocked on the vehicle of the participating carriers). The voucher identifies the traveler and trip purpose, origin and destination, and fare. After paying the minimum user fee ($1.50), the traveler signs the voucher acknowledging his belief that the current trip is not eligible for funding from any other federal or state program. For any fare beyond the maximum trip subsidy limits, the user must pay the additional amount.

The carriers check and tally the vouchers and then submit them to the county for reimbursement. After the vouchers are reviewed by hand for completeness, the program pays the carrier 90 percent of the billing within two to four weeks and 10 percent after an audit. The manual review of the vouchers helps detect any irregularities concerning users' name, ID numbers, addresses, and trip purposes. In one case, the program refused to pay a set of suspect vouchers prepared by a taxi driver and the taxi company subsequently sued him to obtain the money it had payed him. The program also has taken a small sample of vouchers and telephoned the users to inquire about their trips.

<u>Benefits</u>

Based upon a one percent sample survey of regional households in 1977, about 12,000 persons in the County may be considered eligible for the program. About two years after the program began (December 1980),

over 7,000 persons had enrolled, representing almost 60 percent of the eligible population. When the registration fee was introduced, the total enrollment dropped to about 4800 persons. It is believed that most of the persons who did not pay the registration fee either could not participate (moved, health changed, died, etc.) or had not really been taking trips. Tables S1.1 through S1.3 summarize the travel impacts of the program/1/. No information is available about the socioeconomic characteristics of the users or their travel behavior in absence of the program. Wheelchair users account for the largest share of those enrolled and of the total ridership (Table S1.1). During an average month only 25 percent of the eligible wheelchair users and 30 percent of those requiring walkers actually use the program compared to over 40 percent for the blind and those requiring crutches. Persons needing crutches take the highest average number of trips, while those needing walkers take the lowest average (Table S1.2).

No single trip purpose dominates, with medical, recreation, work, and personal travel purposes reported (Table S1.3). Although the program does not maintain information on individual participation, it examined small random samples of vouchers for some months. This showed that about 200 persons were making more than 30-40 trips per month while the average number of trips for the program is less than about seven per month (see Table S1.2). Thus, like the Seattle accessible bus services and the Portland lift program, it appears that a relatively small number of eligible individuals account for much of the subsidized travel. The program may survey these heavy users to understand their needs and to explore the implications of new restrictions.

Table S1.1: USER-SIDE SUBSIDY PROGRAM PARTICIPATION BY DISABILITY--1979

	Percent of Total Eligible Persons	Percent of Total Enrollment	Percent of Total Trips
Disability			
Require wheelchair	57	68	59
Require walker	17	10	6
Require crutches		6	11
Blind	26	16	24

/1/ Derived from Charles River Associates, Inc. (1982).

Table S1.2: PROGRAM PARTICIPATION BY ENROLLED PERSONS--1979

	Percentage of Disability Group Using Program Each Month	Average Number of Trips per Person
Disability		
Require wheelchair	25	6.8
Require walker	30	5.1
Require crutches	42	8.1
Blind	42	6.8

Table S1.3: USER-SIDE SUBSIDY PROGRAM TRIPS BY PURPOSE

	Percentage of Trips
Trip Purpose	
Work	15
Shopping	8
Personal Business	15
Education	5
Recreation/Social	17
Medical	19
Nutrition	1
Other/No Answer	20

The handicapped travelers have benefited from transportation companies competing for their business. Taxicab companies have recognized a new importance for this market and have improved their service for wheelchair users. (A $3.00 fare surcharge is allowed by the program.) The chaircar industry has expanded (from one provider to three) during the program. As a result of this, providers have longer service hours, offer more service flexibility, and attempt to differentiate their services to retain regular users. The competition between taxi and chaircar providers has also helped keep service quality high and chaircar fares down.

Cost and Cost-Effectiveness

Data are available on the user payments and subsidy costs per trip by disability classification for 1979 and 1980/2/. Unfortunately, no information exists on the start-up costs during 1978 or the administrative costs for the first 1 1/2 years of the program. During the third year (1980), program administration, accounting, and marketing were managed by a full-time coordinator with two full-time assistants. In 1980 the direct administrative costs (not including general overhead such as office facilities) amounted to 55 cents per trip, or about 8 percent of the subsidy costs per trip.

For an agency establishing a program like Milwaukee's, we estimate that start-up costs would be on the order of $50,000 in 1980 dollars. Because administrative costs will vary due to the type of certification process and the number of registrants as well as how trip vouchers are processed, we will estimate the administrative expenses at about 10 percent of the subsidy costs per trip. In 1980 the subsidy cost per trip was $6.83 and the user payment was $1.26. (The minimum user payment was raised to $1.50 in 1981 resulting in an average revenue of $1.71). Assuming that in the first year 5,000 trips per month will be made, rising to 11,000 per month in the second year and to 14,000 per month for subsequent years, we calculate the average total cost per trip over a five-year program period as $8.91 in 1980 dollars, the revenue as $1.26 (exluding any annual registration fees), and the net program cost per trip as $7.65 (see Table S1.4). (No information is available on average trip length to compute costs per trip mile.)

Alternatives

Some concern exists about how to control increasing ridership each year because of the limited funding. (The consent agreement ties the program funding to a percentage of the transit system's operating budget.) One option involves tighter restrictions on eligible users, perhaps by serving only those who are physically unable to use buses without lifts. This change would make many blind persons ineligible for the program. Other options would be to place monthly limits on total trip making (or total trip subsidy) or to try to restrict certain trip purposes. If it becomes necessary to impose limits on individuals, computer processing of the vouchers may be required. Automated processing also could improve the auditing, accounting, and provider paying functions.

Although some of the user-side subsidy trips could be funded by other (federal or state) social service programs, it is difficult to identify such trips and have them paid for by the appropriate agency or program. The county sponsored a study to examine ways to address this

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/2/ See Charles River Associates (1982), p. 61.

problem/3/. The study concluded that the costs of administering a total coordination mechanism to involve the four major programs could be substantial, and the county has yet to determine that such an effort would be worthwhile.

Table S1.4: SUMMARY ASSESSMENT FOR MILWAUKEE PROGRAM

Demographic Characteristics	
Eligible Handicapped Users	12,000
Eligible Users Registered	40%
Total Population (1980)	965,000
Program Characteristics	
Trips served per year	112,000
Program cost per year	$865,800
Performance Measures	
Total cost per trip	$8.91
Revenue per trip	$1.26
Program cost per trip	$7.65

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

Taxis currently carry over half of the total trips (about 54 percent), but receive only about 40 percent of the subsidy funds (which represent about one fourth of the company revenues.) Apparently, this is due to the higher costs of serving wheelchair users. The chaircar companies require 24 hours advance notice to help them schedule trips (although companies try to provide service on shorter notice). Taxi operators, however, handle the program trips in the same way as their regular trips. Some increased efficiency might be possible if the taxis

/3/ Multisystems, Inc. (1982).

offered shared-ride service (which would be a requirement for using UMTA funding). By giving users a fare discount for making advance reservations, some shared-riding could be possible.

References

Charles River Associates (1982) "The Milwaukee County User-Side Subsidy Program: A Case Study". Report No. UMTA-MA-06-0049-82-4, Cambridge, Mass.: U.S. Department of Transportation, Transportation Systems Center.

Multisystems, Inc. (1982) "Feasibility and Design Study: Brokerage of Specialized Transportation in Milwaukee County," Final Report, Cambridge, Massachusetts: Multisystems, Inc.

Case Study S2: Pittsburgh's Centralized Management of Specialized Services

Allegheny County, located in southwest Pennsylvania, has a population of over 1.45 million people (1980) and an area of 728 square miles. Pittsburgh, with a population of about 424,000, is situated almost in the center of the county at the juncture of three rivers. These rivers, combined with numerous valleys and high hills, often make direct travel within the county difficult. The county population declined almost 10 percent between 1970 and 1980, while the percentage of residents over age 65 increased from 11 to 13.9 percent.

In mid-1975 a planning study examined the potential of coordinating paratransit services for the general public as well as special users in the Pittsburgh region. This study recommended that an independent central management organization be created to design, contract for, market and administer services but not to operate or subsidize them. In July 1978, the Port Authority of Allegheny County, which operates the regional transit system, obtained an UMTA Service and Management demonstration grant to test the coordination approach/1/. Within a few months, the Port Authority hired ACCESS Transportation Systems Inc. to be the management organization on a cost plus fixed fee basis for 3 years. In March 1979 the first traveler began using the ACCESS system.

The central management organization performs several service design, contracting, marketing, and administrative functions:

- solicits proposals annually for door-to-door services in seven sectors of the county;
- selects taxicab companies and non-profit human service agencies to provide service and then negotiates contracts with them;
- pays the selected taxi providers on a vehicle service hour basis (or occasionally the regular meter rate) and pays the agency carriers on a hourly rate;
- monitors provider records and performance and establishes driver training and operating procedures;
- markets its transportation services to all human service agencies, and schedules about half of the participating agency trips (individuals and other agencies call carriers directly);
- answers telephone inquiries about special user transportation;
- sells Port Authority scrip, which provides persons who cannot use mass transit because of physical disability a 75 percent

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/1/ Three legal issues regarding taxicab ride-sharing regulatory authority, opposition from taxi operations, and labor protection concerns had to be resolved before the grant was approved. See Charles River Associates (1983) Section 4.

fare discount on ACCESS services,/2/ and

- collects used scrip from carriers and submits records to the Port Authority for the fare discount credit.

Initially ACCESS offered service only weekdays from 6:30 a.m. to 10:30 p.m. Weekend service began after one year and service hours were extended from 6:00 a.m. to 12 p.m. One-day in advance reservations generally apply, although individuals can request same-day service if carriers have capacity on pre-scheduled trips. About 10 percent of the non-agency user's trips are same-day requests.

Prior to the coordination program several different types of providers served elderly and handicapped users. Seven taxi companies operated in the county. In 1977 two carried over 8,000 Area Agency on Aging (AAA) client trips per month. The AAA, the county mental health and mental retardation organizations, and other human service agencies also operated vehicles and purchased transportation services from taxi companies for their clients. In 1977 over 50 agencies offered some sort of transportation to their clients.

Initially ACCESS contracted with seven providers for services. By 1982 eleven (six taxi operators and five non-profit agencies) were under contract. Taxi companies carried over 70 percent of the ACCESS trips in both taxicabs and vans. The non-profit carriers served about 30 percent, primarily in regular and lift-equipped vans. The two largest taxi companies in the county carry about 65 percent of all ACCESS trips. During 1979-1982, from 24 to 38 human service agencies per year have purchased services through ACCESS. Although the demonstration activities stimulated new demand for paratransit services, no new carriers (either profit or non-profit) entered the paratransit market. The entry of new carriers was discouraged by both PUC restrictions on new taxi operations and by ACCESS's provider selection criteria.

This case study summarizes the ridership and cost impacts of the coordination and the handicapped 75 percent fare discount programs during the demonstration period (1979-1982). Since the fare discount program began concurrently with the coordination program, it is not possible to examine the independent effects of either program.

Benefits

An estimated 20.9 percent of the county population (303,400 individuals in 1979) were eligible (age 60 or older and/or handicapped) for ACCESS

/2/ ACCESS established a 195 zone fare system for all users in 1979 which was intended to cover the transportation costs (excluding the administration costs). Because ridesharing by ACCESS users has been much lower than expected, however, fare revenues have covered only about 50 percent of the transportation expenses.

services/3/. However only an estimated 2 percent of the county population, or 30,300 people in 1979, were eligible for the 75 percent Port Authority scrip fare discount. About two years after the program began, over 2,900 persons had registered for ACCESS cards, representing about 1 percent of the total eligible population. In addition, an indeterminant number of elderly and handicapped persons could be considered registrants because they are clients of some 20 to 30 participating social service agencies.

Travel diary surveys of ACCESS registrants and interviews of agency clients provided some information on ACCESS user travel. Trip rate data are available only for ACCESS registrants. Little trip making information exists, however, for the agency sponsored travelers who make about 40 percent of all ACCESS trips. Each month over 50 percent of the registrants typically do not travel at all. A small number (14 percent), however, take over 17 trips per month (Table S2.1).

Exhibit S2.1: PARTICIPATION IN THE ACCESS PROGRAM, 1981

	Number of Persons	Percent of Those Eligible for a Fare Discount	Percent of all ACCESS Registrants*
Fare discount trips per month			
over 17	410	1	14
9-16	250	1	9
1-8	700	3	24
none	1,540	5	53
Did not register	27,400	90	0
Totals	30,300	100	100

Note: *All these people obtained ACCESS cards; 90 percent have fare discount cards, and 10 percent pay full fare.

The agency sponsored persons are quite different from the unaffiliated persons who have registered with ACCESS (Table S2.2). Not surprisingly, the agency sponsored persons are predominately over 60 and either non-handicapped or handicapped but can board a bus. The agency-sponsored users also have much

/3/ A small number of non-elderly or non-handicapped individuals who are clients of participating social service agencies also are eligible.

Table S2.2: PARTICIPATION IN ACCESS BY GROUP, 1981

	Percent of All Eligible Persons*	Percent of ACCESS Registrants#	Percent of Non-Agency Trips	Percent of Agency Users
Group				
60 & over, handicapped (can use bus)	8	7	10	19
60 & over, cannot board bus+	7	54	41	19
60 & over, non-handicapped	79	2	0	54
Under 60, handicapped (can use bus)	3	3	0	1
Under 60, cannot board bus+	3	34	49	7
Household Income				
Under $5k	N.A.	27	N.A.	60
$5k to $10k		35		31
$10k to $15K		14		6
Over $15k		24		3

Notes: *Persons over 60 years of age or handicapped.
+Persons eligible for Port Authority fare discount.
#Non-agency affiliated persons who have obtained ACCESS cards. Ninety percent of the cardholders have fare discount cards and 10 percent pay full fare.

lower household incomes than the ACCESS cardholders. One group of the ACCESS registrants, those under 60 who cannot board a bus, represent only about 34 percent of the registrants but take almost half of the non-agency trips.

Work and medical trip purposes account for over half of the fare discount user trips, while medical purposes dominate agency sponsored travel (Table S2.3). Table S2.4 suggests that for the agency sponsored users the ACCESS program served primarily trips that would have been made in the absence of the program. Almost two-thirds of the agency clients interviewed indicated that they would have walked or wheeled if the agency had not provided transportation.

Table S2.3: ACCESS TRIPS BY PURPOSE, 1981

	Percent of Fare Discount Users	Percent of Agency Sponsored Users
Trip purpose		
work	28	-
education	9	-
shopping	6	3
medical	24	94
personal business	17	-
recreation/social	11	2
other	5	1

Table S2.4: TRAVEL BEHAVIOR IN ABSENCE OF ACCESS PROGRAM, 1980

	Percent of Agency Sponsored Users
Alternative	
no trip	14
walk (wheel)	65
auto driver	7
auto passenger	4
taxi (full fare)	-
other, bus	10
don't know	-

ACCESS users have benefited by improved service availability both geographically and temporally. The number of accessible vehicles has grown from 24 before the demonstration to about 55 in 1982. Service quality, as measured by on-time performance, speed, and directness of travel, appears to be better than before the demonstration. Unfortunately, the more direct travel and better speed has been achieved at the expense of less ride sharing and decreased vehicle productivity.

ACCESS users have paid fares that cover only about half of the direct transportation costs for their trips. Those eligible for the fare discount scrip pay only about one eighth of the direct expenses. In addition, users did not have to pay for any of the coordination activities such as providing information on travel options, monitoring service, and training drivers.

Cost and Cost-Effectiveness

Data is available on the administrative costs, the transportation expenses, the user payments, and the transit agency's disabled fare discount program contributions for the period 1979 to mid-1982./4/ While information exists on the start-up activities performed by the transit agency and ACCESS during 1978 and early 1979, the actual costs of these activities are difficult to determine. By the third year (1981), ACCESS had seven staff members (four full-time) to perform the coordination activities and administer the fare discount program. (The transit agency also had some staff members involved in administering the ACCESS contract and the fare discount program). In 1980, the direct ACCESS adminstrative costs averaged $2.96 per trip, declining to less than $2.00 in 1982 as ridership increased.

For an agency setting-up a program like Pittsburgh's, we estimate that start-up costs (planning, selecting a coordination organization, contracting with providers, and marketing) would be about $100,000 in 1980 dollars. The ongoing annual administrative costs would be $350,000 in the first and second years, and $300,000 in the subsequent years (all in 1980 dollars). The annual transportation costs would be $750,000 in the first year, $1,350,000 in the second year, and $1,600,000 in subsequent years. By using a five year program period and a 10 percent discount rate, and assuming that in the first year 6,500 trips per month will be made, rising to 13,000 per month in the second year, and to 16,000 per month for subsequent years, we calculate the average total cost per trip as $10.62 in 1980 dollars, the revenues as $3.30 (including a user payment of $.83 and revenues from social service agencies of $2.47), and the net program cost per trip as $7.32 (see Table S2.5). The average administrative cost per trip is $2.06 (twenty percent of the total trip cost).

Alternatives

After the demonstration ended in July 1982, the ACCESS fares were increased in an effort to have them better reflect the transportation and administrative costs. At the same time the transit agency scrip fare discount went from 75 to 80 percent. Under this new schedule, the user payment per

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/4/ Charles Rivers Associates (1983).

Table S2.5: SUMMARY ASSESSMENT FOR THE PITTSBURGH PROGRAM

Demographic Characteristics	
Eligible users*	303,400
Eligible users registered+	2,900
Total population (1980)	1,450,000
Program Characteristics (annual)	
Trips served per year	130,700
Program cost per year	956,700
Performance measures	
Total cost per trip	\$10.62
Revenue per trip	\$3.30
Program cost per trip	\$7.32
Program cost per trip mile	\$1.63

Notes: * Estimates of persons over 60 years of age or handicapped.

+ This is the number of ACCESS card holders. Clients of some 20-30 social service agencies also can use ACCESS.

Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

trip, if eligible for the discount, went from about \$1.20 to \$1.80, a 50 percent increase. Charges to the human service agencies also rose, some by as much as 300 percent!

Rather than contracting annually with taxi and non-profit carriers for per vehicle hour subsidies, the program could employ a user-side subsidy approach like Milwaukee's (see Case Study S1) to involve all qualified providers for services anywhere within the county. This approach would allow the users to choose providers and encourage carriers to compete for each trip. Carriers might offer more attractive service or offer lower fares to attract (and retain) users. Without PUC restrictions, new carriers might enter the market if they could attract significant number of users. Providers might encourage more ridesharing by offering a fare discount with advance reservations. Many of the current administrative activities such as negotiating

annual contracts, monitoring carrier records, and training drivers would be eliminated.

Reference

Charles River Associates, Inc. (1983). "Paratransit Brokerage Demonstration Project: Pittsburgh, Pennsylvania", Draft Final Report, Boston, Mass.

Case Study S3: The Portland Specialized Dial-a-Ride Service

In 1977 elderly and handicapped persons who could not use the fixed route service in Portland (Oregon) were offered the option of taking "The LIFT," a door-to-door service provided by the public transit authority with 15 medium-sized buses equipped with retractable lower steps and wheelchair lifts. Service that could not be supplied conveniently by the bus system was provided by two taxi operators under contract to the transit authority. Under an UMTA demonstration grant, service was available weekdays from 7 a.m. to 7 p.m. and users were required to request service 48 hours in advance. The fare was $.50 for eligible users not affiliated with a social service agency, while agencies were billed at rates of $2.00 to $3.00 per trip. There was no limit on individual use of the system.

Benefits

Out of a total population in Portland of roughly 380,000, about 22,000 (5.8 percent) were eligible to participate in the LIFT program. Tables S3.1 through S3.4/1/ summarize the travel impacts of the program. As for the Danville RTR program (case study S5), it was possible to identify the individual user for each LIFT trip. Consequently, the number of user making various numers of trips per month could be computed (table S3.1). However, information about the number of trips per month made by various socioeconomic subgroups was not available, and table S3.2 provides only the age and income distributions for the registrants and the total eligible population.

The LIFT program attracted an even smaller proportion of the eligible population than the RTR program: virtually all of the trips were made by just five percent of the eligible persons. A much higher proportion of LIFT trips were for medical purposes than was found for the RTR program, which tended to serve a broader range of trip purposes. Table S3.4 suggest that like the RTR program, the LIFT program served primarily trips that would have been made in the absence of the program (though the proportion of new trips was significantly higher for LIFT than for RTR).

During the first year of the service over 80 percent of the trips were served by LIFT buses and 20 percent were served by taxicabs, even though over 50 percent of the registrants reported that they had no difficulty using a taxi. Some 15 to 20 percent of the users were wheelchair bound, however. The LIFT program probably resulted in a slight (but negilible) increase in VMT in Portland.

Costs and Cost-effectiveness

Data available on the costs for the first year of service/2/ include estimtes of the transit authority administrative expenses, the direct operating costs, and depreciation charges for the 15 specialized buses. In

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/1/ Derived from Cooper et al. (1978) and Spear et al. (1978). Cooper et al. (1979) provide a later assessment, including results in the second year.

/2/ Cooper et al (1978); see Cooper et al (1979) for the second year results.

Table S3.1: LIFT PARTICIPATION BY ELIGIBLE PERSONS

	Number of Persons	Percent of Total Eligible Persons	Percent of Total LIFT Trips (7300/Month)
Trips per month by registered persons			
More than 8	420	2	74
1-8	630	3	26
0	3,150	15	0
Did not register	16,800	80	0
Total	21,000	100	100

Table S3.2: LIFT PARTICIPATION BY SOCIOECONOMIC GROUPS

	Percent of Total Eligible Persons	Percent of Total Registrants
Age		
65 & over	69	77
under 65	31	23
Household income		
under $5,000	51	66
$5,000 to $10,000	23	16
over $10,000	26	18

October 1977 the total cost for the average passenger trip on the LIFT buses was $8.04 and on the taxi service $5.69. Since the average taxi trip length was about 5.8 miles and the average bus trip length was about 4.3 miles, the cost per passenger trip mile by taxi was $0.98 and by LIFT bus was $1.87.

For a city implementing a program like the Portland LIFT service, we estimate that the start-up costs would be of the order of $45,000 in 1980 dollars. (Unfortunately, no information on the actual start-up cost in Portland is available.) The total administrative, operating, and depreciation costs per year would be about $803,000 in 1980. Assuming first year ridership of 666 per month on the taxicabs and 4700 per month on the buses and stable

Table S3.3: LIFT TRIPS BY PURPOSE, DECEMBER (1977)

	Percent of Trips
Trip purpose	
work	14
shopping	5
personal business	15
medical/dental	56
recreation	8
other	2

Table S3.4: TRAVEL BEHAVIOR IN ABSENCE OF LIFT PROGRAM, DECEMBER 1977

	Percent of Trips
Alternative	
no trip	36
don't know	16
auto driver	3
auto passenger	7
full-fare taxi	15
regular bus	11
social service agency	12

ridership levels of 888 per month on the taxicabs and 6260 per month on the buses for subsequent years, we calculate the average total cost per trip on the system over a five year program period as $10.09 in 1980 dollars, the revenue as $2.61 (including revenue from social service agencies), and the net program cost per trip as $7.48 (see table S3.5).

Alternatives

The wide disparity between the LIFT bus and taxi costs and the large number of bus riders who could use a taxicab suggested that the taxi operators should provide more of the service. During the second year, the amount budgeted for taxi service was doubled to $110,000 and more riders were served by taxis. The two major taxi operators provided the service under contract to the transit authority with each responsible for the service every other month. An alternative would be to employ a user-side subsidy approach to involve all qualified private and public transportation providers. The users could then choose which provider to patronize, and the operators could provide different

Table S3.5: SUMMARY ASSESSMENT FOR THE PORTLAND PROGRAM

Demographic chacteristics	
Eligible users	22,000
Eligible users registered	20%
Total population	380,000
Program characteristics (annual)	
Trips served per year	67,240
Program cost per year	$503,000
Performance measures	
Total cost per trip	$10.69
Revenue per trip	$2.61
Program cost per trip	$7.48
Program cost per trip	$1.67

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

services and compete for riders. This approach could include different subsidy levels for various user types: the wheelchair bound riders, for example, could be subsidized at much higher levels. In 1980, the transit agency stopped operating the buses and contracted for services with three non-profit organizations and a taxi operator/3/.

References

Bloomfield, P.; Cooper, T.; & Flynn, S. (1981). "Special Needs Transportation in Portland: Implementation and Dismantling of the LIFT Project," Transportation Research Record 830, Washington, DC: Transportation Research Board.

/3/ Bloomfield et al. (1981).

Cooper, T.; Bloomfield, P.; & Flynn, S. (1978). "The LIFT: Portland's Special Needs Transportation Demonstration Project." Report No. UMTA-OR-06-004-78-2 by Crain and Associates, Washington, DC: US Department of Transportation.

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Spear, B. D.; Page, E. A.,; Slavin, H.; & Hendrickson, C. (1978). "Recent Evidence from UMTA's Service and Methods Demonstration Program Concerning the Travel Behavior of the Elderly and Handicapped." Staff Study SS-24-U.3-161, Cambridge, Mass.: US Department of Transportation.

Case Study S4: The Seattle Lift Equipped Bus Service

In August 1979 buses equipped with wheelchair lifts were introduced on portion of the regularly scheduled, fixed route transit system in metropolitan Seattle and other areas of King County, Washington (1979 estimated population 1,231,500). Initiated by the transit agency, the performance of the system was monitored by UMTA/1/. The service began on two routes and increased incrementally to close to 43 percent of the bus trips scheduled on 24 routes by the summer of 1980. Eight coaches were dedicated to the service during the peak hours, representing roughly 17 percent of the total peak scheduled fleet. On weekdays, headways between accessible buses were approximately one hour on half of the routes and half an hour or less on the remainder. Weekend srvice was slightly less frequent. Anyone physically unable to climb bus steps was eligible to use the lift. The fare for the handicapped users was 15 cents compred to the regular transit fares of 50 cents for one zone and 75 cents for more than one zone.

Benefits

Of the estimated 1,850 wheelchair users in King County/2/, about 96 persons or 5 percent of this population used the accessible bus service in 1980. Seattle's lift use as a percent of total revenue ridership was one of the highest in the country, .04 percent. Seven lifts counts between February and December 1980 produced an average daily boarding of 56. There appeared to be seasonal fluctuation in usage with a peak of 68 boardings in July.

Tables S4.1 through S4.3 summarize user characteristics and travel impacts based upon a survey of all lift users who could be located and interviewed. A very small group of individual's accounted for much of the ridership (table S4.1). Most of these individuals were recurrent users; 60 percent of them made three or more one-way trips per week. The major trip purposes were work and recreation (table S4.2), and the buses were serving primarily trips that would have been made by driving with others or by taxi in the absence of the program (table S4.3). Sixty-seven percent of the users reached bus stops unassisted; the remaining 33 percent sometimes traveled with an attendant. Sixty-seven percent of the users made transfers between vehicles, mostly for work trips.

Questions on the socioeconomic characteristics of lift users revealed an age distribution not too different from the general transit-riding public; 79 percent of users were between the ages of 20 and 54, and only eight percent were over 65. Sixty-seven percent of the users indicated that they lived at private residences; the remainder lived in special housing for the handicappped or in nursing homes. The distance from user's homes to the bus stops varied greatly; but over 51 percent lived more than three blocks away. Most of the users were wheelchair bound; only 9 percent of all lift boardings were made standing.

/1/ Crain & Associates (1981) describes the service as of Summer 1980.

/2/ Assumes wheelchair users make up .15% of the total population.

Table S4.1: SEATTLE ACCESSIBLE BUS USE BY ELIGIBLE PERSONS

	Number of Persons	Percent of Handicapped	Percent of Trips Per Month (1375/Month)
Trips per month			
more than 8	25	1.4	44
1-8	71	3.8	56
none	1,751	94.8	0
Total	1,847	100.0	100

Table S4.2: SEATTLE ACCESSIBLE BUS TRIP PURPOSES

	Percent of Trips
Trip purpose	
work	25
shopping	19
school	7
recreation	22
personal business	17
medical	6
other	3

Table S4.3: TRAVEL BEHAVIOR IN ABSENCE OF SEATTLE ACCESSIBLE BUSES

	Percent of Users
Alternative	
auto passenger	38
taxi	19
auto driver	16
social service agency	11
other	6
no mode	10

Increased independence is an obvious benefit of the program. Only twenty-nine percent of the users possessed a driver's license, and of these only 19 percent always or sometimes had an automobile available to drive. A majority of those who formerly depended on rides with others or on social service agencies cited increased independence as the most important reason for switching to accessible transit; cost savings was the most common reason give for people switching from other modes to accessible transit. Forty-five percent of the users were also registered for the transit agency's scrip program/3/.

The survey did not directly ask whether trip making had increased as a result of the new service. However, 81 percent pf the users responded that they were now able to perform more activities or be more independent than before.

Another survey -- this time of potential users -- showed non-users to be older, more dependent on non-wheelchair aids and needing more assistance in getting around outside the house. A major reason for not using the service was a preference for other means of transportation. There is undoubtedly some benefit to handicapped persons who, even though they have not used the service, have the option and thus can consider themselves more like the general public.

Costs and Cost-effectiveness

For a transit agency instituting an accessible bus service such as the Seattle system, the start-up costs (planning, marketing and training costs) would be about $80,000 in 1980 dollars. Other ongoing annual costs would be $70,000 for maintenance costs, $45,000 for staff administrative costs, and $84,200 depreciation charges for the lifts. (The total capital cost was $1,010,600; 163 lifts at $6,200 per vehicle.) By using a five-year program period and a 10 percent discount rate, and assuming an average ridership of 16,500 trips for the first year and 33,000 trips per year for subsequent years, we calculate the average cost per trip at $7.52 in 1980 dollars: $2.21 administrative, $2.41 maintenance, and $2.90 capital (see table S4.4). (Since no information was obtained on average trip length, costs per passenger trip mile could not be calculated.) With a 15¢ fare, the net program cost or subsidy per trip comes to $7.37. Appendix B describes these calculations in detail.

Seattle's service record and on-time performance have been relatively impressive compared to other lift-equipped systems/4/. Over a four-month period in 1980, the transit agency averaged one lift repair about every 12 lift boardings and one lift-related service interruption every 35 lift boardings. (This is equivalent to one lift repair every 2,800 miles of accessible

/3/ A county-wide user-side subsidy program permits elderly and handicapped individuals to purchase $10.00 booklets of taxicab scrip for $6.00. There is no limit on frequency of use on trip purpose. Some of the cab companies operate lift-equipped vehicles. See Koffman (1982).

/4/ See Rosenbloom (1981).

Table S4.4: SUMMARY ASSESSMENT FOR SEATTLE LIFT EQUIPPED BUS SERVICE

Demographic characteristics	
Eligible wheelchair users	1,850
Eligible users riding	5%
Total population (1979)	1,231,000
Program characteristics (annual)	
Trips served per year	24,200
Program cost per year	$178,500
Performance measures	
Total cost per trip	$7.52
Revenue per trip	15 cents
Program cost per trip	$7.37

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year period.

service and one service interruption every 8,400 miles of accessible service.) Point checks performed by the transit agency showed that the introduction of accessible service had essentially no impact on schedules. However, drivers did perceive some increase in route time on trips involving lift operations.

Seattle's comparatively low per passenger costs and high ridership levels can be attributed to several factors. Among them, the temperate climate and the transit agency's genuine support for full accessibility are probably the most important. The use of second generation lift equipment has also been important and has spared Seattle from the severe mechanical problems which have plagued many other systems using accessible buses/5/.

Costs may tend to increase, however. The first routes chosen for accessible service had the greatest potential ridership. As more routes are added, it may become increasingly difficult to achieve the same ridership levels per route. In addition, the longer term reliability and maintenance costs of the lifts are uncertain. However, increased mainstreaming of handicapped individuals in the future could increase demand and help to keep

/5/ See Englisher & Wexler (1983).

costs per trip down.

Alternatives

It appears that it may take considerable time and several other changes (such as removing sidewalk and architectural barriers and providing escorts) before large numbers of handicapped persons in wheelchairs will change their behavior. Lift use varied considerably across routes. Usage counts showed that four routes accounted for 59 percent of total daily lift use. A promising alternative to offering accessible service on all routes would be to provide fully accessible service on targeted routes and specialized dial-a-ride services for other areas.

Reference

Crain & Associates (1981). "Lift-Equipped Bus Service for Seattle, Washington," Draft Report for the Transportation Systems Center, Cambridge, Mass.: US Department of Transportation.

Englisher, L. & Wexler, A. (1983). "Accessible Bus Serivice in the Washington, D.C., Metropolitan Area," Report No. UMTA-DC-06-0239-83-1, Cambridge, Mass.: US Department of Transportation, Transportation Systems Center.

Koffman, D. (1982). "A Taxi Scrip Program in Seattle, Washington," Report No. UMTA-MA-06-0049-82-2, Cambridge, Mass.: US Department of Transportation, Transportation Systems Center.

Rosenbloom, S. (1981). "Bus Transit Accessibility for the Handicapped in Urban Areas," Synthesis 83, National Cooperative Highway Research Program, Washington, DC: Transportation Research Board.

Case Study S5: The Danville Reduced Taxi Rates Program

Danville, Illinois, is a small city of 43,000 located four miles from the Illinois-Indiana boundary. Average family income is close to the national median income of about $13,000, and the proportion of elderly persons (13 percent) is higher than the proportion nationally (9.9 percent). In March of 1975 the City of Danville applied to UMTA for a demonstration grant to test the user-side subsidy concept as a means of improving the mobility of elderly and handicapped persons. The grant was awarded and in December of 1975 a new Reduced Taxi Rates (RTR) program began providing shared taxi services to elderly and handicapped persons at 25 percent of the regular fare (up to a monthly limit of $20 in total full fare value). In January of 1977 the regular shared taxi fares were increased by an average of 13 percent, and the program participant's share was raised to 50 percent of the new rates. The RTR program continued at these fares and participant shares through July of 1978. (In November of 1977 a new fixed route mass transportation service was introduced in Danville for the general public. This service will be described in the following section on general purpose travel). The benefits and costs discussed here for the RTR program apply to the period when the 25 percent fare payment was in effect.

The RTR program employed a charge slip scheme for disbursing subsidy funds. Eligible users obtained an identification card from city staff and then chose among the two or three companies offering shared taxi services in the city. On completion of a trip, eligible users paid their share of the fare in cash and signed a charge slip specifying the total fare and the amount paid in cash. The taxicab companies submitted these signed charge slips to the city on a weekly basis and were reimbursed for the subsidized portion of the fares. The RTR project operated in Danville for two years and seven months, and for the last six months the project competed for ridership with the new fixed route service.

Benefits

The travel impacts of the RTR program are summarized in tables S5.1 through S5.4/1/. The charge slip scheme employed in the RTR program identified the fare paid and the individual user for each RTR trip. As a result it has been possible to compute the number of users making various numbers of trips per month (table S5.1) and the average number of trips made per month by several socio-economic sub-groups of the eligible population (table S5.2). In addition, on-board surveys of RTR users provided the information in table S5.3 on the purposes of RTR trips. An indication of likely travel behavior in the "do-nothing" base case was obtained by asking RTR users what they would have done in regard to the trip they were making in the absence of the RTR program (table S5.4).

/1/ Derived from FitzGerald (1977).

Table S5.1: RTR PARTICIPATION BY ELIGIBLE PERSONS, 1976

	Number of Persons	Percent of Total Eligible Persons		Percent of Total RTR Trips (8500/month)
<u>Trips per month by registered persons</u>				
More than 10	320	4		41
5-10	405	5	=36	31
1-5	2010	27		28
0	640	9		0
Did not register				
"No need"	2805	37		0
In-accessible	124	2	=55	0
Other reasons	1196	16		0

Table S5.2: RTR PARTICIPATION BY SOCIOECONOMIC GROUPS, 1976

	Percent of Total Eligible Persons	Percent of Total Registrants	Percent of Total RTR Trips
<u>Group</u>			
65 & Over, Handicapped	18	19	17
65 & Over, Non-Handicapped	65	63	52
Under 65, Handicapped	17	18	31
<u>Household Income</u>			
Under $5K	52	73	89
$5K - $10K	36	24	8
Over $10K	12	3	3

Table S5.3: RTR TRIPS BY PURPOSE

Trip Purpose	Percent of Trips
Work	7
Shopping	33
Personal business	21
Medical	15
Recreation	17
Other	7

Table S5.4: TRAVEL BEHAVIOR IN ABSENCE OF RTR PROGRAM

Alternative	Percent of Trips
No trip	15
Auto driver	1
Auto passenger	16
Full fare taxi	50
Walk	15
Other	3

Tables S5.1 through S5.4 suggest that the benefits of the RTR program were enjoyed by certain sub-groups of the eligible population, with the highest usage groups being low income and handicapped persons. The suggestion in table S5.4 that 85 percent of thr RTR trips would have been made in the absence of the program is perhaps a little surprising at first, though it can be reasoned that this is what should be expected when a program is aimed at facilitating trips which are valued highly by the travelers. It is worth noting that table S5.4 implies that the RTR program increased VMT in Danville, since the VMT generated per trip by the shared taxi service probably equals or exceeds that generated by the alternatives listed.

The fare reduction for RTR users at the beginning of the RTR program in December 1975 and the fare increases which took effect in January 1977 provided an opportunity for estimating fare elasticities for RTR users and for shared taxi riders in general. McGillivray (1978) shows that the arc fare elasticities for the initial RTR fare decrease, the RTR fare increase, and the general fare increase for shared taxi riders are all approximately -0.6. If we assume that this arc fare elasticity is constant along the demand curve for RTR eligibles, the net consumer surplus accruing to RTR users as a result of the first phase of the RTR program (December 1975 through December 1976) can be estimated at $0.74 per trip in 1980 dollars/2/.

Costs and Cost-Effectiveness

For a public agency instituting a program like RTR in 1980, the start-up costs would be approximately $19,200 (inflating the $14,000 reported by FitzGerald (1977) for 1976). The fares and administrative costs per year would be about $179,200 in 1980/3/. Using a five-year program period with a 10 percent discount rate, and assuming an average ridership of 7000 trips/month for the first year and 8500 trips/month for subsequent years, the average total cost per trip would be $1.88 in 1980 dollars: $0.43 user payment, $1.16 fare subsidy, and $0.29 administrative cost. If the average trip length of 2 miles were maintained, the program cost per passenger trip mile would be $0.73/4/. Table S5.5 summarizes these results. Appendix B illustrates how to calculate these performance measures.

Alternatives

Perhaps the most obvious alternative to the RTR program is a publicly operated dial-a-ride system. While the cost of $1.88 per RTR trip is substantially lower than most general purpose dial-a-ride costs, it is possible that such a dial-a-ride system might have attracted a different segment of the eligible population. Comparison of market penetration by the RTR service with that achieved by general purpose dial-a-ride services would shed some light on this question.

/2/ See Appendix C for this calculation.
/3/ FitzGerald (1977).
/4/ Passenger trip miles are given by the product of passenger trips and average trip length.

Table S5.5: SUMMARY ASSESSMENT FOR THE DANVILLE RTR PROGRAM

Demographic Characteristics	
Eligible Users	7,500
Eligible Users Registered	40%
Total Population	42,000
Program Characteristics (Annual)	
Trips served per year	81,450
Program Cost per year	$118,100
Performance Measures	
Total Cost per Trip	$1.88
Revenue per Trip	$0.43
Program Cost per Trip	$1.45
Program Cost per Trip Mile	$ .73

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

References

FitzGerald, P. G. (1977). "User-Side Subsidies for Shared-Ride Taxi Service in Danville, Illinois: Phase I." Report No. UMTA-IL-06-0034-77-1, Cambridge, Mass.: U.S. Department of Transportation. NTIS: PB 292-805.

McGillivray, R. G. (1978). "Fare Elasticities for On-Call Paratransit Services." Working Paper 1186-3-1. Washington, D.C.: The Urban Institute.

Case Study S6: Kinston's User-Side Subsidy for the Elderly and Handicapped

Kinston, the county seat for Lenoir County, is a small rural community of approximately 25,000 located in the central coastal plain of North Carolina. Trip lengths in Kinston are relatively short because of its small land area (8.9 square miles) and the fact that the closest metropolitan area is 60 miles away. Median family income and auto ownership rates are considerably below national rates. The proportion of elderly persons in Kinston closely matches the national level, however. The primary public transportation service is provided by taxicabs, with eight firms and over 40 vehicles. No city bus service exists and very little social service agency transportation is available.

The UMTA Office of Service and Management Demonstration sponsored this project to test the user-side subsidy concept as a mechanism for improving elderly and handicapped mobility. Termed KITE (Kinston Independent Transportation for the Elderly), the program provides shared-ride taxi services to eligible users at 50 percent of the regular taxi fare. To be eligible for the program, an individual must be at least 65 years of age or handicapped, and a resident. These eligibility requirements are verified in a brief personal interview. The program employs as its subsidy mechanism tickets which can be purchased at nine locations. To control the size of the program budget, eligible users are limited to $25 worth of subsidized trips per month. These restrictions have been waived, however, in hardship cases, especially for handicapped persons who use taxis to go back and forth to work daily. The city guards against fraud by issuing ID cards which must be shown at the time of ticket purchase and tripmaking. Tickets have the user's ID number and taxi drivers can compare ticket numbers with ID card numbers.

Eligible users arrange for their own rides and can choose from among six taxi firms participating in the program. Subsidized trips must be taken within the city limits. At the end of the trip, the user pays the fare in tickets. Fares are based on a zonal rather than a meter system. (A four-zone fare system was established shortly before the program started to encourage shared riding.) Taxicab drivers turn in their logbooks and tickets to the City and are reimbursed within a few days. Since the end of the demonstration period, the program has continued with Section 18 funds.

Benefits

The travel impacts of the KITE program are summarized in tables S6.1-S6.4/1/. Taxi on-board surveys, registration interviews and taxi ticket use records provided information on registered users. A survey of non-registrants described the eligible users who did not register for the program.

Table S6.1 suggests that very small subgroups of the eligible population are receiving most of the benefits from the program. This table shows that 50

/1/ Derived from Nelson (1980). Very few changes have been made to the KITE program since this evaluation. Registration currently is running over 1,000 and average trips per month are approximately 2,500. The percentage of work-related trips have more than doubled.

percent of all program trips are made by just 3 percent of all eligible users and 89 percent are made by just 8 percent. The results of the surveys of users and non-participants suggest, however, that the program helps those who are the most transportation disadvantaged. Asked why they did not register for the program, over 70 percent of all non-participants responded that they have superior travel options available. Of those who actually use the program, Table S6.2 shows that the poor and handicapped receive benefits which exceed their representation in the general population. Of those who used the program most frequently, over 90 percent did not have an automobile iarticipants suggest, however, that the program helps those who are the most transportation disadvantaged. Asked why they did not register for the program, over 70 percent of all non-participants responded that they have superior travel options available. Of those who actually use the program, Table S6.2 shows that the poor and handicapped receive benefits which exceed their representation in the general population. Of those who used the program most frequently, over 90 percent did not have an automobile in their household.

Table S6.1: KITE PARTICIPATION BY ELIGIBLE PERSONS

	Number of Persons	Percent of Total Eligible Persons		Percent of Total KITE Trips (3000/month)
Trips per Month by Registered Person				
10-60	118	3		50
5-9	220	5	17	39
1-4	346	9		11
0	50	1		0
Did not register	3418	82		0
TOTALS	4152	100		100

The program appears to be primarily a mechanism for allowing the mobility disadvantaged to use more preferred modes (taxis instead of walking or depending on someone else for a ride). Table S6.3 shows that almost all project trips would be made in the absence of the program, 84 percent by taxicabs. This seems reasonable if one assumes that the users are making trips which are highly valued. When interviewed, users reported only a small increase in overall tripmaking (3.5 percent). Interestingly, users in wheelchairs report no problems utilizing the service and eligible nonregistrants do not cite the lack of lift equipment as a reason for nonparticipation.

Table S6.2: KITE PARTICIPATION BY SOCIOECONOMIC GROUPS

	Percent of Total Eligible Users	Percent of Total Registrants	Percent of Total KITE Trips
Group			
65 & over	90	80	70
Under 65, handicapped	10	20	30
Household Income			
Under $5K	76	90	93
$5K - $8K	11	5	5
$Over $8K	12	5	2

Table S6.3: TRAVEL BEHAVIOR IN ABSENCE OF KITE PROGRAM

	Percent of Trips
Alternative	
Auto driver	3.7
Auto passenger	5.6
Full fare taxi	84.3
Walk	5.6
Social service agency vehicle	0.0
Other	0.9

Table S6.4: KITE TRIPS BY PURPOSE

	Percent of Trips
Trip Purpose	
Work/School	9
Shopping/Personal Business	59
Medical	20
Visit Friends, Relatives	11
Recreation, Entertainment	0
Social Service Agency	0
Religious	1

Costs and Cost-Effectiveness

Project records provided information on program costs/2/. For a public agency instituting a program like KITE in 1980, the start-up costs would be approximately $9,110. Fare subsidies and administrative costs combined per year would be about $66,464 in 1980. Using a five-year program period with a 10 percent discount rate, and assuming an average ridership of 2,250 trips per month for the first year and 3,000 trips per month for subsequent years, the average total cost per trip would be $2.36 in 1980 dollars: $.86 user payment, $.86 fare subsidy, and $.64 administrative cost. With an average trip length of 2.5 miles, the program cost per passenger trip mile would be $.60.

Table S6.5: SUMMARY ASSESSMENT FOR THE KINSTON KIT PROGRAM

Demographic Characteristics	
Eligible Users	4,152
Eligible Users Registered	18%
Total Population	25,000
Program Characteristics (Annual)	
Trips Served Per Year	28,200
Program Cost Per Year	$42,288
Performance Measures	
Total Cost Per Trip	$2.36
Revenue Per Trip	86 cents
Program Cost Per Trip	1.50
Program Cost Per Trip Mile	60 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year period.

/2/ Charles River Associates, Inc. (1980).

Alternatives

An alternative to the KITE program would be for the City to award an exclusive contract to one taxi company. If Kinston had had only one dominant taxi operator, this might have been a convenient option. The existence of several equally-sized operators, however, made the user-side subsidy approach a logical choice. Rather than having to choose between the operators on the basis of formal service proposals, the City has been able to encourage the users to make their own choices, thereby promoting continuing trip-by-trip competition between the operators. The increased volume of taxi business apparently has been responsible for the entrance of two new taxicab companies, an unlikely outcome under the exclusive contract approach.

References

Nelson, M. (1980), "User-Side Subsidies for Shared-Ride Taxis in Kinston, North Carolina," Report No. UMTA-NC-06-0002-80-1, Washington, D.C.: U.S. Department of Transportation.

Chapter 5

GENERAL PURPOSE TRAVEL EXAMPLES

A GUIDE TO EXAMPLE PROGRAMS

This chapter considers general purpose public transportation programs -- those which have multiple objectives and serve a number of different travel markets instead of, or in addition to, the home-to-work or special user group markets. Almost all conventional transit services are included in this category, because their home-to-work and special user group services are rarely separated from the "base service." Exhibits 9 through 11 list a number of general purpose programs in areas of different sizes, and case studies for several of these programs follow. Those cases which are reported in most methodological detail are again identified with an asterisk. Exhibit 12 lists references for sources of more detailed information about the example projects not chosen as case studies.

Exhibit 9: GENERAL PURPOSE TRAVEL EXAMPLES FOR RURAL & SMALL URBAN AREAS

example, and case study number	setting	service area population (thousands)	type of service	situation exemplified
Chapel Hill (N.C.)	university community	30	fixed-route evening service	taxis provide fixed-route service
G1.* Danville (Il.)	isolated agricultural	43	fixed-route, dial-a-ride	user-side subsidy, buses & taxis
Merced (Ca.)	isolated agricultural	30	dial-a-ride	city-operated DAR
Merrill (Wi.)	small isolated town	10	route deviation	novel service type
G2.* Westport (Ca.)	small city, suburb	30	fixed-route, dial-a-ride	municipal/private operator integration
G3. Winona (Mi.)	small isolated city	28	route deviation	novel service type

* Case study developed in greatest methodological detail.

Exhibit 10: GENERAL PURPOSE TRAVEL EXAMPLES FOR MEDIUM-SIZED URBAN AREAS

example, and case study number	setting	service area population (thousands)	type of service	situation exemplified
Ann Arbor (Mi.)	city, university campus	106	fixed-route, dial-a-ride	integration of service forms
Chattanooga (Tn.)	inner city area	220	jitney	unsubsidized private operators
G4. Cheseapeake (Va.)	suburban	300	taxi-feeder	contract taxi service
El Cajon (Ca.)	small city suburban	60	dial-a-ride	contract taxi DAR
Evansville (In.)	isolated city	139	fixed-route	city-operated transit
G5. Mercer County (N.J.)	urban county	300	fixed-route transit	off-peak fare abolition
Peterborough (Ont.)	small city	59	taxi-feeder	contract taxi service

Exhibit 11: GENERAL PURPOSE TRAVEL EXAMPLES FOR LARGE URBAN AREAS

example, and case study number	setting	service area population (thousands)	type of service	situation exemplified
G6.* Atlanta (Ga.)	metropolitan area	1,000	bus transit	fare reduction, service increase
Haddonfield (NJ)	4 suburban towns	44	dial-a-ride	transit authority DAR
G7. Hopkins (Mn.)	suburban	14	shared-taxi	user-side subsidy, taxis
G8. Jacksonville (Fl.)	metropolitan area	580	bus transit	fare increase
G9. Johnson County (Ks.)	suburban	200	bus transit	switch from public to private provider
G10. Memphis (Tn.)	urban area	646	bus transit	fare increase, service reduction
Orange County (Ca.)	city, suburban	82	dial-a-ride	contract taxi service
Rochester (NY)	2 suburban areas	105	dial-a-ride	contract taxi service
St. Bernard (La.)	suburban	25	taxi-feeder	novel service type
G11. Silver Spring (Md.)	surburban	77	fixed-route bus feeder	county-operated service

* Case study developed in greatest methodological detail.

Exhibit 12: REFERENCES FOR EXAMPLES NOT USED AS CASE STUDIES

type of area	example	source of further information
RURAL & SMALL URBAN	Chapel Hill (N.C.)	Gilbert, Garber, & Forester
	Merced (Ca.)	US Department of Transportation (1976c)
	Merrill (Wi.)	US Department of Transportation 1976d)
MEDIUM URBAN	Ann Arbor (Mi.)	Neumann, Wojno, & Juster (1977)
	Chattanooga (Tn.)	Brooke (1976)
	El Cajon (Ca.)	US Department of Transportation (1976b)
	Evansville (In.)	US Department of Transportation (1976c)
	Peterborough (Ont.)	Ontario Ministry of Transportation & Communications (1975)
LARGE URBAN	Haddonfield (NJ)	Mouchahoir (1975)
	Orange County (Ca.)	Miller (1978)
	Rochester (NY)	Neumann & Holoszyc (1980)
	St. Bernard (La.)	Ernst & Miller (1979)

Case Study G1: The Danville Runaround Program

In Danville, two versions of the user-side subsidy concept were implemented under UMTA demonstration grants: the first to provide shared-ride taxi services for the elderly and handicapped as described in Case Study S5, and the second to provide scheduled and on-call fixed route service for the general public. Privately operated fixed route transit existed in Danville until 1970, and the new fixed route system, the Runaround, restored transit services in November 1977. The Runaround system employed a special set of administrative procedures for involving private operators and reimbursing them on a user-side subsidy basis. Riders pre-purchased Runaround tickets from some 32 ticket outlets in the city and used them to pay for Runaround service/1/. Runaround providers then submitted the used tickets to the City on a weekly basis and were reimbursed at pre-arranged rates. Every four months existing and potential new providers were invited to propose service and fare levels at which they could operate profitably on the basis of reimbursement guidelines announced by the City. Any conflicts between the providers over routes and fare structures were resolved through discussions between the providers and City planning staff, and contracts were negotiated specifying service levels and reimbursement rates for each provider over the next four month period/2/.

During the fourth service period, which began November, 1978, the Runaround services were provided over eleven routes between 6 a.m. and 6 p.m. Monday through Saturday by two private transportation companies, American Transit Corporation (ATC) and Red Top Cab Company (RTC). ATC operated five 45-passenger buses over seven routes on 30 minute and 60 minute headways, while RTC operated a 21-passenger minibus over two routes on 60-minute headways and regular taxicabs over two other routes on an on-call basis. Free transfers were available between all routes. ATC's contract provided for a payment of $1.85 per ticket collected, while RTC's contract specified $1.50 per ticket. Both contracts included maximum total payments for the four-month period. Unsubsidized shared taxi service continued to be provided by RTC and one other small operator, and carried about 15,000 passengers per month at an average fare of $1.50.

Benefits

After 12 months of service development, Runaround ridership levels had experienced some variations but were growing steadily, with fourth period ridership of about 22,000 per month. It should be noted these

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/1/ Full-fare tickets cost 40 cents each and were available in books of 5 and 20 tickets, while half fare tickets were available to the elderly, the handicapped, and children under 16 in books of 10 tickets. In addition, an unsubsidized cash fare of $1 was established.
/2/ See Kirby & Tolson (1979) or Bloomfield et al (1980) for a complete description.

are complete trips based upon ticket counts and do not include transfers between routes. Tables G1.1 through G1.3 summarize the Runaround travel impacts suggested by an early on-board survey/3/. (More recent information is available in Koffman and Bloomfield (1980).) The Runaround was serving largely work, school, and medical trips, but according to table G1.3 had generated relatively few new trips. Some one-third of all the Runaround trips apparently were diverted from the Danville shared taxi system, and 12 percent were diverted auto passenger trips (probably relieving some residents of providing ´serve

Table G.1: RUNAROUND PARTICIPATION BY SOCIOECONOMIC GROUPS

	Percent of Total Population	Percent of Total Trips (22,000/month)
Age Group		
under 20	27	20
20 - 64	60	63
over 65 years	13	17
Handicapped	4.5	8

Table G1.2: RUNARUND TRIPS BY PURPOSE

	Percent of Trips
Trip Purpose	
Work	39
Shopping	7
School	21
Medical	14
Recreational/Social	6
Other	13

/3/ This survey was made only four months after the Runaround began and while the reduced rate taxi service was still available for elderly and handicapped users. It appears that the youth, elderly and handicapped riders may be under-represented in the returns.

passenger´ trips)/4/.

Table G1.3: TRAVEL BEHAVIOR IN ABSENCE OF RUNAROUND PROGRAM

	Percent of Trips
Alternative	
No trip	8
Auto driver	24
Auto passenger	12
Shared taxi	30
Walk	22
Other	4

Costs and Cost-Effectiveness

The total operating costs during the fourth service period for both companies were estimated to be $146,000, which includes vehicle depreciation for the privately owned buses and taxis. The city administrative costs for the four-month period were about $18,500, which included the staff, office space, and printing costs for the tickets and service schedules. Advertising costs were about $2,700. Because this was a demonstration project there were some administrative costs (such as managing data collection activities and preparing reports) that should be excluded if the costs are to be compared with those for other systems. The total operating cost for the fourth service period was about $167,800 or $41,950 per month, about 11 percent of which was for city administrative expenses/5/. This does not include about $46,000 of start-up costs incurred at the beginning of the project.

For a public agency instituting a program like the Runaround in 1980, the start-up costs would be approximately $55,100 (inflating the $46,000 incurred in 1978). The on-going costs would be $559,000 per year in 1980 dollars. Using a five-year program period with a 10 percent discount rate, and assuming an average ridership of 17,000 per month for the first year and 24,000 per month for succeeding years, the average cost per Runaround trip would be $2.14 in 1980 dollars: $0.34 user payment, $1.49 fare subsidy, and $0.31 administrative cost. For

/4/ Calculations in Appendix A suggest that the Runaround probably effected a small net increase in VMT, since the reductions in automobile travel were not large enough to offset the increased VMT resulting from the Runaround services themselves.
/5/ See Koffman & Bloomfield (1980) for more detailed cost information.

an average trip length of 2 miles, the overall cost per passenger trip mile would be $1.07. The summary assessment measures for the program are found in table G1.4. Appendix B describes these calculations in detail.

Table G1.4: SUMMARY ASSESSMENT FOR THE DANVILLE PROGRAM

Demographic Characteristics	
Total Population	42,800
Area (square miles)	12.9
Average Density (persons/sq. mile)	3,318
Median Annual Household Income	$13,000
(1976 est)	
Program Characteristics (Annual)	
Trips served per year	223,300
Program cost per year	$401,900
Performance Measures	
Total Cost per Trip	$2.14
Revenue per Trip	$0.34
Program Cost per Trip	$1.80
Program Cost per Trip Mile	$1.07

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

Given that Danville wishes to support general public mass transportation services, several alternatives to the Runaround system might be considered. Firstly, the user-side subsidy approach, which involves

a rather costly pre-paid ticket system, might be abandoned in favor of a provider-side approach such as contracting with providers on the basis of a cost plus fee payment per in-service mile. Secondly, the restriction to fixed route operation could be lifted and areawide shared taxi services considered. The total cost per passenger trip on the Runaround system was close to the average shared taxi fare for the same trips, making shared taxi or dial-a-ride service a serious option to fixed route service in Danville.

References

Bloomfield, P., Koffman, D., & Bruno, L. (1980). "The Runaround: User-Side Subsidies for Fixed-Route Transit in Danville, Illinois," in Transportation Research Record 761. Washington, D.C.: Transportation Research Board.

Koffman, D. & Bloomfield, P. (1980). "The Runaround User-Side Subsidies for Mass Transportation in Danville, Illinois," Report No. UMTA-IL-06-0034-80-1. Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation.

Kirby, R. F. & Tolson, F. L. (1979). "Supporting Mass Transportation in Small Urban Areas Through User-Side Subsidies: A Demonstration in Danville, Illinois". Working Paper 1186-4-1. Washington, D.C.: The Urban Institute.

Case Study G2: The Westport Minnybus and Maxtaxy Program

Westport, a small suburban town of about 28,000, is located in the south western part of Connecticut, about a one-hour drive from New York. Residential density is about 1,300 persons per square mile, and residents are relatively affluent: average annual household incomes for 1976 were in excess of $26,000. In 1974 a newly formed Westport Transit District (WTD) began operating a "Minnybus" service oriented to the downtown during the day and to the rail stations during the commuter hours. The daytime service consisted of seven loop routes, with all vehicles scheduled to arrive at the center of town every 35 minutes to permit convenient transfers. Almost all riders used annual passes ranging in price from $15 to $40. The commuter service operated along 11 routes and met selected trains at two stations. An annual pass for this commuter service costs $65.

In 1976 efforts were made to integrate the private taxi operations into the WTD system to better serve the elderly and handicapped and to improve the door-to-door service available to the general public/1/. With an UMTA demonstration grant, 12-passenger vans were purchased and a central dispatching center was established. A private company formed by a bus operator and a taxi operator was awarded a contract to provide a "Maxytaxy" dial-a-ride service with these vehicles. The cost plus fixed-fee contract negotiated with the company contained productivity incentives to encourage service efficency.

Several attempts were made to involve the two private taxi operators directly in the Maxytaxy system, but agreements could not be reached and one company went to federal court in an unsuccessful attempt to stop the project. (About a year after the dial-a-ride service began, both private taxi firms had ceased operating their taxi services.) Fares for the Maxytaxy service were based on a zone system and produced an average revenue per person trip of about $1.40. Elderly users received a 25 percent fare discount, and specialized advance-request service for the elderly and handicapped was available for only $0.25. Package delivery services were also provided.

Benefits

Average monthly passenger boardings on the fixed route system were about 50,000 during 1978; about 39,000 daytime boardings and approximately 11,000 commuter trips. Over 20 percent of the daytime boardings were transfers made during a trip. After 20 months the dial-a-ride ridership had grown to an average of 13,000 passenger trips per month. About 10 per cent of the trips were by elderly persons, and 5 percent were by handicapped individuals. In addition, over 1,000 package deliveries were made. Before they ceased operations the two private taxi companies were serving between 5000 and 6000 trips per month.

/1/ See Green (1978) for a more complete description.

Late in 1978 a new private operator began to offer exclusive ride service with two limousines.

On-board surveys for a single day in November 1977 provide estimates of the travel impacts of the WTD services/2/. The information from these surveys is summarized in tables G2.1 through G2.3/3/.

Table G2.1: WTD PROGRAM PARTICIPATION BY SOCIOECONOMIC GROUPS

	Percent of Total Population	Percent of Trips		
		Minnybus Daytime (31,000/month)	Minnybus Commuter (11,000/month)	Maxytaxy (13,000/month)
Age Group				
under 20	25	72	0	21
20 to 64	67	23	95	67
over 65 years	8	5	5	12
Handicapped	3	-	-	5

Table G2.2: WTD PROGRAM TRIPS BY PURPOSE

	Percent of Trips		
	Minnybus Daytime (31,000/month)	Minnybus Commuter (11,000/month)	Maxytaxy (13,000/month)
Trip Purpose			
Work	22	100	42
Shopping	25		10
School	15		5
Medical	8		10
Recreation	30		19
Other			14

/2/ This was eight months after the Maxytaxy service started and the regular private taxis were still operating.

/3/ Derived from Westport Transit District (1977). See Furniss (1979) for similar information collected in 1978 and 1979.

Perhaps the most striking feature of these results is the market differentiation between the three services listed: the daytime Minnybus, the commuter Minnybus, and the Maxytaxy. The daytime Minnybus service, which accounts for some 56 percent of WTD ridership, was heavily patronized by teenagers and served more social/recreation trips than any other purpose. The commuter Minnybus served residents over the age of 20 making work trips. And the Maxytaxy carried a large number of work trips (serving the train station after Minnybus hours), as well as recreation and other trips by adult residents.

As shown in table G2.3 the daytime Minnybus apparently was serving a substantial number of trips which would not have been made in the absence of the service. These trips were mainly teenage recreation travel. The commuter trips all would have been made in the absence of the service, almost exclusively as auto driver or auto passenger trips. The Maxytaxy also tapped some previously unserved travel demand, though the vast majority of those trips also would have been made anyway. A substantial proportion of the trips for all three services would have been auto passenger trips, so that many family members and friends probably were relieved of providing ´serve passenger´ trips. And sixty percent of the commuters left a car at home for possible use by other family members/4/. Table G2.3 also suggests that there was a significant degree of competition between the different WTD services and regular taxi services: 14 percent of Maxytaxy riders would have taken the Minnybus in the absence of the Maxytaxy service, and 22 percent would have taken a regular taxi.

Table G2.3: TRAVEL BEHAVIOR IN ABSENCE OF WTD PROGRAM

	Percent of Trips		
	Minnybus Daytime	Minnybus Commuter	Maxytaxy
Alternative			
No trip	45	-	20
Auto driver	9	60	11
Auto passenger	27	33	25
Regular taxi	2	1	22
Walk, other	11	6	8
Minnybus	-	-	14
Maxytaxy	6	-	-

/4/ Calculations in Appendix A show, however, that the WTD system probably effected a modest increase in VMT in Westport.

Costs and Cost-Effectiveness

We can present some preliminary cost data supplied by the system director and supplement these data with some of our estimates. A detailed analysis of the individual service costs is also now available/5/.

The operating costs in 1980 dollars for the dial-a-ride service average about $40,000 per month while the Minnybus system costs about $35,800 per month. Adding estimates of the vehicle capital costs brings these costs to $43,700 and $39,200 per month respectively. We have not attempted to estimate the administrative costs which include the staff, office space, and materials, because we do not have detailed information and some of the costs are associated only with the demonstration. Start-up costs and some marketing costs are also excluded. With these exclusions, the cost per passenger trip for the Maxytaxy service was about $3.36, with an average user payment of $1.34 and a subsidy of $2.02, while for the Minnybus service the cost for a complete passenger trip was about $0.95, with $0.30 user payment and $0.65 subsidy. The average total cost per trip for all the WTD services was about $1.56, excluding administrative and start-up costs, with $0.56 user payment and $1.00 subsidy. Assuming an average trip length of 2.5 miles we estimate that the cost per passenger trip mile was $0.67. A set of summary assessment measures for the program is presented in table G2.4. Appendix B illustrates how to calculate performance measures.

Alternatives

The alternative to the WTD services most often mentioned was the construction of additional parking spaces at a cost of $1 million. (The costs avoided by not building those parking spaces were sometimes cited as a benefit of the WTD system while the benefits foregone went unmentioned.) Other alternatives which might have been considered include an aggressive car and vanpooling program for commuters, a discount taxi ticket program for the elderly and handicapped, and per-ride pricing schemes on the Minnybus system designed to reduce the overcrowding which sometimes occurred.

/5/ Furniss (1979).

Table G2.4: SUMMARY ASSESSMENT FOR THE WESTPORT PROGRAM

Demographic Characteristics	
Total Population	29,300
Area (square miles)	22.4
Average Density (persons/sq. mile)	1,308
Median Annual Household Income (1976 est)	$26,000
Program Characteristics (Annual)	
Trips served per year	648,000
Program cost per year	$648,000
Performance Measures	
Total Cost per Trip	$1.56
Revenue per Trip	$0.56
Program Cost per Trip	$1.00
Program Cost per Trip Mile	$0.40

Start-up, administrative, and some marketing costs are unavailable and hence not included.

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

References

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Case Study G3: Winona Transit Service with Route Deviations

In December 1977, the towns of Winona and Goodview in Minnesota (1970 combined population of 28,400) undertook a new service that uses the same vehicles to transport three submarkets at different times of the day. Starting with three vehicles operating simultaneously over a single long route, the system was modified in early 1979 to five buses running over four routes/1/. In the early mornings and late afternoons, the service is aimed at the commuter market and provides regular route transportation to residential and business areas. In the midday, the service takes the form of a flexible route service, allowing route deviations to meet the special needs of the transportation disadvantaged such as those requiring doorstep service/2/. On weekends and evenings, the service becomes a subscription/charter service geared to destinations and schedules of people likely to attend events such as church functions, senior citizen activities and college programs. A taxicab company operates the system under contract to the city. The first project to begin operations under a state paratransit demonstration program, its performance is monitored annually by the state/3/.

For the average rider there is a two block walk to the bus stop, a 20 minute ride time and a transfer time of no more than a few minutes. All residents of Winona and Goodview are eligible to use the service. The regular transit fare is 30 cents; each route deviation costs an additional 10 cents. Senior citizens and youths are eligible for a 10 cent reduction on each trip. A ten dollar monthly pass is also available and entitles the user to unlimited rides. Passholders must pay an additional ten cents per route deviation, however. About 45 percent of all passenger revenues come from passes and token sales.

Benefits

The Winona Transit Service (or WTS) replaced a less extensive service named Cabus. This earlier service used two limousines to provide half hourly service over a somewhat shorter route than initially adopted by WTS. Cabus annual ridership was approximately 66,000 prior to the introduction of WTS. In its first year of operation, WTS ridership almost doubled this amount, reaching 120,000. The service expansion in the second year resulted in an additional ridership increase of about 40 percent. Ridership has varied considerably by season, peaking in the winter months.

In the first year of service, six percent of the riders on average used the route deviation service each month. After the route modifications in 1979, which made the fixed routes more accessible, this percent dropped to four percent.

/1/ Two additional buses provide supplemental peakhour capacity.
/2/ Since none of the vehicles are lift-equipped, the city leases a special vehicle to provide dial-a-ride service to handicapped users.
/3/ See Minnesota Department of Transportation (1980).

Tables G3.1 through G3.3 summarize the socioeconomic characteristics of the users and the travel impacts of the service. These tables present the findings from two on-board surveys -- one of WTS users, the other of Cabus users -- and one telephone survey of the general public. Compared to the general population, a higher percentage of the system's patrons are female, live in households with earnings less than $5,000 per year, and are without a car. The age profile of WTS users shows that 33 percent are elderly and eight percent are under 19 (see table G3.1). WTS has been more successful than Cabus in attracting younger riders and riders with automobiles, and in penetrating the home-to-work travel market.

Table G3.1: WTS PROGRAM PARTICIPATION BY AGE GROUPS

	Percent of Total Population	Percent of Service Users (10,000 trips/month)
Age Group		
under 19	3	8
19 to 64	69	59
65 or older	28	33

Table G3.2: WTS TRIPS BY PURPOSE

	Percent of Service Users
Trip Purpose	
Work	35
Shopping	30
School	10
Social/Recreation	9
Medical/Dental	5
Other	9

Table G3.3: TRAVEL BEHAVIOR IN ABSENCE OF WTS PROGRAM

Alternative	Percent of Service Users
Auto passenger	25
Bus (old Cabus service)	24
Auto driver	12
Other	19
No trip	12

The vast majority of the route deviation users are elderly; during the spring of 1979 over 90 percent of the route deviation trip makers were senior citizens, mostly traveling to a noon-time nutrition program. Shopping is another primary trip purpose for the elderly. Most of the non-elderly are traveling to work.

Table G3.3 indicates the changes in travel behavior as a result of the new service. It shows that 12 percent of the users are making new trips and that 24 percent were former Cabus users.

Costs and Cost-Effectiveness

For a city implementing a service such as WTS in 1980, the first-year costs would be on the order of $170,000 in 1980 dollars. (Start-up costs are not available.) On-going costs would be about $232,000 in 1980 dollars for subsequent years. Assuming a first year ridership level of 120,000 trips and a level of 180,000 for subsequent years, the average cost per trip over a five year program period would be $1.31 in 1980 dollars, the average revenue per trip 34 cents and the net program cost per trip 97 cents (see table G3.4). Of the $1.31, about 80 percent would go towards vehicle operations, and ten percent towards administration.

Alternatives

The WTS ridership during the first 16 months suggests that the prepaid passes, marketing and promotion, and system expansion have been reasonably effective. The system costs and performance measures are reasonable compared to other small bus systems. The bus system does not appear to have adversely affected regular taxi ridership.

The current operation could be modified with more buses and further route changes, or dial-a-ride services could be considered. These changes probably would have minimal effects on ridership or total costs, however. Lower fares or pass charges could stimulate ridership, but probably would increase total program costs.

Table G3.4: SUMMARY ASSESSMENT MEASURES FOR THE WINONA PROGRAM

Demographic Characteristics	
Total Population (1970)	28,400
Area (square miles)	12.0
Average Density (person/square mile)	2,225
Program Characteristics (Annual)	
Trips served per Year	138,100
Program Cost per Year	$134,000
Performance Measures	
Total Cost per Trip	$1.31
Total Revenue per Trip	34 cents
Program Cost per Trip	97 cents
Program Cost per Trip Mile	36 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

Reference

Minnesota Department of Transportation (1980). "Winona Transit Service with Route Deviation." Paratransit Demonstration Project Evaluation Report No. 1, Office of Transit Administration, St. Paul, Minnesota.

Case Study G4: The Chesapeake Maxi-Taxi Feeder Service

The Tidewater Transportation District Commission, operating under the name Tidewater Regional Transit (TRT), serves the Norfolk-Portsmouth-Virginia Beach urbanized area in Virginia with about 150 peak hour buses operating on over 50 routes. In 1979, TRT began a number of experimental services using privately operated vehicles in lower density areas and during low demand times such as late evenings. By early 1981, over 10 different services had been started, although some had been terminated because of low ridership. This case study documents a taxicab feeder service termed Maxi-taxi which was introduced in September 1979.

The TRT was concerned about the high passenger deficit on two longer routes serving a very low density portion of the city of Chesapeake within the urbanized area. This area covered over 20 square miles and contained mostly single family residences and rural development. To reduce bus operating costs, the two routes were terminated at a shopping center. In place of the bus service, the TRT contracted with a taxi operator (at an hourly rate) to provide Maxi-taxi feeder service from 6 a.m. to 7 p.m. The operator leases a 12-passenger van from TRT to provide the service. A traveler in the feeder area calls the taxi company for home pick-up, which is usually provided within one hour. On the return trip, a user boards the Maxi-taxi at scheduled times (hourly) at the shopping center location. Riders buy a two-part ticket for $1.00 from the Maxi-taxi driver. One part of the ticket allows users to ride TRT buses without paying another fare. The bus fare on the previous bus routes was 50 cents.

Benefits

During 1980, average monthly passenger ridership was about 1,250. Over the last three months of the year ridership averaged over 1,660 per month. By comparison, the monthly ridership on the two previous bus routes averaged about 1,130 passengers. Since no user surveys have been made, no information is available on the travel impacts of the Maxi-taxi feeder. It appears, however, that the new service has stimulated new ridership even though the user fares have doubled/1/.

Costs and Cost-Effectiveness

The operating costs in 1980 dollars for the Maxi-taxi feeder service averaged about $3,400 per month. We have not attempted to estimate the TRT administrative costs associated with the contract. The start-up costs and marketing expenses are also unavailable.

/1/ Tidewater Regional Transit (1981).

Table G4.1 presents the summary assessment measures for the service assuming ridership was 1,300 per month in the first year and 1,700 for succeeding years. It is also assumed that operating costs increased from $41,000 in the first year to $63,700 in succeeeding years (in 1980 dollars). Excluding start-up, marketing, and administrative costs, the cost per passenger trip would be $3.03, with a user payment of $1.00, and a subsidy of $2.03. (No information is currently available on average trip length.)

Table G4.1: SUMMARY ASSESSMENT MEASURES FOR CHESAPEAKE FEEDER SERVICE

Demographic Characteristics	
Area (square miles)	20
Average Density	very low
Program Characteristics (Annual)	
Trips served per year	16,050
Program cost per year	$32,582
Performance Measures	
Total Cost per Trip	$3.03
Total Revenue per Trip	$1.00
Program Cost per Trip	$2.03

Start-up, administrative, and some marketing costs not included.

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

The previous service alternative, conventional bus service, was estimated by TRT to cost over $4.50 per passenger in 1980. Another way to provide a feeder service would be to involve several taxi and

other qualified private providers through a user-side subsidy approach/2/. Providers would be reimbursed at a set fee per person rather than paid by the hour or mile. As the number of riders increased, providers would be encouraged to carry more shared-ride trips. This increased productivity, as well as provider competition to attract and keep users, should help keep the total subsidy costs down.

References

Miller, G. K. (1977). "Taxicab Feeder Service to Bus Transit," Transportation Research Record 650. Washington, D.C.: Transportation Research Board.

Tidewater Regional Transit (1981). "Deep Creek and Tower Mall Maxi-taxi", Memoranda from Service Development Manager, Norfolk, Virginia; Tidewater Transportation District Commission.

/2/ See Miller (1977).

Case Study G5: The Mercer County Off-Peak Fare Free Transit Program

Mercer County, located between Philadelphia and New York City, has a population of about 317,000 persons living in an area of 226 square miles. Trenton, the state capital for New Jersey, is the major city in the county with about 98,000 residents. There are also three other urbanized centers and several smaller towns. Overall, the county has experienced an increase in both population and employment since 1970 though the city of Trenton has experienced a decline.

Mercer Metro provides county-wide transit service on thirteen routes with a fleet of 96 buses. Approximately 65 percent of the county population live within a quarter mile of a route, including almost all of Trenton. Weekday peak-period headways average about 30 minutes, while daytime off-peak and Saturday buses operate on 30 and 60 minute schedules. Evening and Sunday services have one to two hour headways.

Before the fare free program began, the base fare was 30 cents during the peak periods (6 a.m. to 10 a.m. and 2 p.m. to 6 p.m.) and 15 cents during off-peak hours (10 a.m. to 2 p.m. and after 6 p.m. Monday through Saturday and all day Sunday and holidays). The fare free program, which began March 1, 1978 and lasted 12 months, eliminated the 15 cent fares for all off-peak riders. No other service changes were made during this period.

Benefits

The off-peak fare free program resulted in about a 46 percent increase in off-peak ridership and a 5 percent decline in peak period use, for a net increase of 16 percent in total ridership over what would have been expected with fares/1/. The typical weekday ridership increased about 9 percent from 23,400 to 25,400 trips per day: the off-peak increased by 3,000 trips while the peak decreased by about 1,000 for a net gain of about 2,000 trips per weekday. Saturday ridership increased by about 30 percent during both the off-peak and peak periods; a total ridership increase of about 3,400 trips per day. Sunday ridership grew nearly 70 percent; a gain of almost 2,700 trips.

The total increase in off-peak bus ridership was estimated at about 21,000 person trips per week. The increase was primarily prior bus users traveling more or shifting from peak to off-peak hours. Travel by entirely new users accounted for about 9,000 trips per week or 43 percent of the total increase. According to the user surveys, the fare free trips made by new users tended to be weighted more toward the

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/1/ Peak period ridership accounted for about 65 percent of the total before the program.

younger group than those made by the prior off-peak bus riders (see table G5.1). The fare free bus trips were for about the same purposes as off-peak trips before the program (Table G5.2). As shown in table G3.3 one-third of the new off peak free bus trips would have been made by automobile in the absence of the fare free program; however 37 percent would have been made by walking, taxi, bicycle, or hitchhiking, and 14 percent were shifted from the peak-period service. Only 17 percent of the trips would not have been made in the absence of the program.

Table G5.1: OFF-PEAK RIDERSHIP BY AGE GROUP FOR MERCER COUNTY

	Percent of Total Population	Percent of Trips		
		With Fares	Without Fares	
			Prior Users	New Users
Age Group				
under 16	28	14	18	22
17 to 64	62	78	75	74
over 65 years	10	8	7	4

Source: Connor (1982)

Table G5.2: OFF-PEAK TRIP PURPOSES FOR MERCER COUNTY

	Percent of Trips	
	With Fares	Without Fares
Trip Purpose		
Work	31	26
Shopping	22	24
School	11	11
Medical	5	6
Recreational/Social	14	16
Other	17	17

Source: Connor (1982)

Table G5.3: TRAVEL BEHAVIOR OF NEW OFF-PEAK RIDERSHIP IN ABSENCE OF PROGRAM

Alternative	Percent of Trips
No trip	17
Auto Driver	18
Auto Passenger	14
Peak Period Bus	14
Walk	28
Taxi, bicycle, hitchhiking	9

Source: Connor (1982)

Since there was essentially no change in the bus service provided and about one-third of the new trips would have been made by automobile, the VMT impact was positive. Calculations in Appendix A suggest that an annual VMT saving of about 1.5 million have been effected by the program.

Cost and Cost-Effectiveness

The total cost of the 12-month program was $502,000. The primary expense was the $339,000 in revenues lost from the prior off-peak riders and from the peak period users who shifted to the off-peak. About $10,000 was spent to provide extra service on particularly crowded routes. Administration and management expenses were $126,000, and $45,000 was expended for marketing and publicity.

For a transit agency instituting this off-peak fare free program in 1980, the start up costs would be approximately $129,900 (inflating the $45,000 marketing and $63,000 administrative expenses incurred in 1978), and the on-going costs would be $493,700 (inflating the $339,000 lost revenues and and $73,000 operating and administrative expenses). For a five year program period with a 10 percent discount rate and an average additional ridership of 21,000 trips per week each year, the average cost per trip would be $0.48 in 1980 dollars. For an average trip length of 3 miles, the overall cost per passenger trip mile would be $0.16. The program assessment measures are shown in table G5.4.

Alternatives:

It has been suggested that the greatest value of the fare free

Table G5.4: SUMMARY ASSESSMENT FOR THE MERCER COUNTY PROGRAM

Demographic Characteristics		
Total Population	317,000	
Area (square miles)	226	
Average Density (persons/sq. mile)	1,403	
Program Characteristics (Annual)		
Trips served per year	911,000	
Program cost per year	$437,300	
Performance Measures		
Total Cost per Trip		48 cents
Revenue per Trip		0
Program Cost per Trip		48 cents
Program Cost per Trip Mile		16 cents

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

concept is its use as a promotion device to attract new riders/2/. For this approach, fares would be eliminated for a short period of time (such as three months) and the costs would be considerably lower than for an extended fare free program like Mercer County. Unfortunately, the relationship between the length of fare free service and the type or retention of attracted users is not well understood at present/3/.

Increasing the quality and quantity of both off-peak and peak bus service together with a modest marketing effort might have had a more significant impact on bus ridership than the fare free program. In

/2/ Connor (1982).
/3/ See Train (1981) for the results of a one-month fare free period of transit service in Salt Lake City.

1978 the total cost for all of the Mercer Metro service was $4.054 million. Thus for the $0.5 million cost of the fare free program, all service could have been increased by over 10 percent, an alternative that deserves examination.

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Case Study G6: Atlanta's Bus Fare Reduction and Service Expansion

In March 1972, the publicly-owned Metropolitan Atlanta Rapid Transit Authority (MARTA) reduced fares on the city's bus system which it had taken over twelve days before. The base fare, which had been increased from 35 cents to 40 cents in March 1971, was cut to 15 cents, and all zonal surcharges and the 5 cent transfer charge were abolished. While school fares, special service fares, and services in one suburban county were not affected, in all about 83% of trips on the system benefited from the lowered fare.

Over the twelve month period preceding the fare cut, the volume of "originating trips" (otherwise "revenue trips" or "linked trips") on the system averaged around 3.67 million per month. The ridership profile showed strong seasonal variations, however, as well as a marked secular decline. Extrapolation estimates of the average patronage which would have been experienced over the twelve months following the fare decrease, had the fare cut not been made, are in the range of 3.50 to 3.62 million trips per month.

The ridership response to the price change proved to be greater than the MARTA staff purportedly had expected. Over the three months immediately following the fare change, the originating trip volume averaged 4.35 million, an increase of over 11% from the same months in the previous year. In part to accommodate these heavier loads and in part in line with MARTA's "short-range transit improvement program", the property began to increase the volume of bus miles operated. In the first full year following the fare reduction, the total vehicle miles were increased by about 10.5% over the total provided in the preceding twelve month period.

Benefits

The volume of originating trips carried over the year following the fare cut averaged about 4.25 million per month, up almost 16% from the previous year and between 17% and 23% from the projected patronage in the absence of the changes. This growth was, of course, the result of both the fare reduction and the service increase. Since transit properties often accompany or follow a significant fare change with some adjustments to the service level to keep load factors within an acceptable range, disentangling the separate effects of the two actions is a frequent problem in interpreting the ridership response. It would have been quite feasible to make one change without the other -- the two are not necessarily linked inextricably -- and thus it is necessary to try to identify the individual contributions of the fare reduction and the service increase to the observed patronage growth. The time series regression models of Kemp (1974) suggest that roughly 80% of the projected growth in trips can be ascribed to the fare cut, while the residual 20% was due to the expansion in bus miles. Kemp (1981) shows how transit planners may estimate similar demand relationships for other systems, for a small outlay of staff and computer time.

The increase in the transit riders' benefit as a result of the fare reduction alone is estimated in Appendix C as about $11.6 million in current prices over the first year, or roughly $22.7 million at 1980 prices. Around 93% of this benefit is ascribable to "existing trips" -- trips that were being taken at the higher fare -- while the remaining 7% accrues to the generated trips. Calculated over a five-year period for comparative purposes, the mean annual benefit in 1980 prices was $16.4 million.

By comparison, the service expansion subsequently made over the year following the fare cut generated an additional transit users' surplus of roughly $3.1 million within that time period, or $6.0 million in 1980 prices. The five-year average benefit deriving from the first year's service increment was $4.4 million in 1980 prices. Since the ridership responses to the extra bus miles had probably not stabilized fully by the end of the year, it is likely that these figures underestimate the total user benefit increase somewhat -- this point is discussed further in Appendix B.

There were probably some non-user benefits accruing from these changes too, of course. To the extent that they diverted travelers from lower occupancy vehicles, there may have been some improvements in highway travel times and air quality. Some evidence about diversions from other modes is provided by the on-board interview survey of MARTA patrons conducted eight months after the fare cut. Those respondents who said that they had not used the bus regularly before the fare reduction (so-called "new riders") were asked "How did you make this trip you're taking today before you started using the bus?" Table G6.1 summarizes the responses. Overall, over a fifth of the "new rider" trips were said to be newly generated since the respondent started to use the bus. A further three-fifths were previously made in an automobile, it was claimed, and for two-thirds of those the respondent had driven the car.

These responses do not relate to the whole of the increased patronage between March 1973 and November 1973, since as well as the travel of "new riders" there was also increased tripmaking by people who rode the system prior to the fare cut. By comparing the survey responses with ridership data, MARTA staff concluded that negligible numbers of extra trips were made by "old riders" on weekdays, but that additional riding by these people at weekends accounted for almost 9% of the total patronage increase.

Calculations detailed in Appendix A suggest that both the fare reductions and the additional service produced a net saving in VMT of roughly 42.8 million automobile mile equivalents in the first year following the fare cut, or 35.7 million miles when discounted and averaged over a five-year program period.

But while these calculations of user benefits and VMT may be interesting, MARTA staff would point out that they do not address the primary motives for the short-range improvement program. The main

Table G6.1: CLAIMED PREVIOUS MODE FOR "NEW RIDER" TRIPS

	Percentage of "new rider" trips				
	weekday peak	all weekday	Saturday	Sunday	Total
Trip not made	24	22	29	27	22
Trip made by:					
auto driver	41	42	33	30	41
auto passenger	21	22	19	21	22
taxicab	4	5	6	4	5
other vehicle	7	5	5	3	5
walking	3	4	8	16	5

Source: MARTA (1974)

reason for the fare reduction was to obtain central city endorsement for a 1971 referendum on building and financing a rapid transit system in Atlanta, and the low fare was intended to redress the probable regressiveness of the proposed method of financing by a 1% sales tax/1/. To the Authority, therefore, the key criteria against which the low fare should be evaluated were (i) the extent to which the proposal contributed to the passage of the referendum, and (ii) the effectiveness of the policy in compensating for the regressive sales tax.

On the first of these points, it is difficult to draw any conclusions. As to the income distributional aspects of the sales tax/low fare financing policy, Bates has provided several analyses of the costs and benefits to three broad income groupings/2/. Table G6.2 summarizes the incidence effects on a per family basis. Note that, in the absence of information about how the different income groups value the transit services which they consume, Bates chose to use the system's operating costs -- a rough indication of the total economic costs of providing the services consumed -- as his measure of "benefits." Since this

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/1/ Almy, Hildreth, and Golombiewski (1981).
/2/ These appear in Metropolitan Atlanta Rapid Transit Authority (1975), Bates (1978), and Bates (1981b). The figures (but not the broad conclusions) differ between the three, and the data in the table are derived from the most recent paper. It considers the five year period from July 1972 through June 1977, and all monetary amounts are in current rather than constant dollars.

Table G6.2: NET INCIDENCE OF LOW FARE/SALES TAX FINANCING FY72 - FY77

	annual family income group			
	less than $5k	$5k to $10k	$10k and over	overall
Number of families, 1970	46,200	73,800	137,900	257,900
Cost of service per family ($)	268	179	60	131
Payments per family:				
bus fares ($)	67	45	15	33
sales tax ($)	40	76	108	86
Net "benefit" per family ($)	161	59	-63	12
Ratios of:				
"benefits" to payments	2.5	1.5	0.5	1.1
net "benefits" to income (%)	3.2	0.1	-*	*
"Transit user" families	34,000	36,300	22,800	93,000
Net "benefit" per family ($)	233	197	165	202
"Non-transit" families	12,200	37,500	115,100	164,800
Net "benefit" per family ($)	-40	-76	-108	-86

* denotes less than 0.5%; all monetary amounts are annual means per family in current dollars.

Source: Bates (1981b)

differs from the usage of the word throughout this volume, we place it in quotation marks. The net "benefits" are the annual cost of the services consumed per family, less the revenues collected from fares and from that part of the sales tax used for operating assistance. In effect, then, these net "benefits" sum to the operating subsidies provided from external sources, principally the federal government. Assuming that the federal tax system is either neutral or progressive for Atlanta residents, the table suggests that on this basis the financing mechanism can be judged progressive. Differential transit usage between the income groupings more than redresses the regressivity in the incidence of the sales tax.

Bates also compared the total expenditures on local transportation by the income groups under the MARTA financing scheme with two

alternatives, assuming inelastic total travel demand: (i) a "no transit" situation, with all trips made by private car, and (ii) full recovery of transit operating costs through the farebox. He concluded that the MARTA scheme was the least regressive of the three. We later suggest some other alternative schemes which might have been more appropriate for analysis.

Costs and cost-effectiveness

The dominant cost of a fare reduction to the transit operator is the revenue foregone. There will also be some planning and administrative costs for the fare change, of course, but these will typically be very small by comparison. In the case of the fare cut, calculations in Appendix B suggest that the revenues foregone over the first year were of the order of \$10.2 million in current prices, or \$20.1 million in 1980 dollars. Over a five-year program period, the discounted lost revenues average \$14.5 million per year at 1980 prices. Note that this is likely to be an underestimate in that it takes no account of the abolition of zonal surcharges, for which the data are not available and which may have contributed significantly to the system's pre-reduction revenues. These costs translate into a price to the system (in 1980 dollars) of at least \$2.52 per additional originating trip attracted because of the fare change. There may also have been some additional costs to users which should properly be taken into account in any full accounting: extra travel time costs or discomfort costs associated with serving the increased patronage volume with the old level of supply. But we have no data to assess these costs.

The costs of the service change were mostly the increase in operating costs associated with the additional supply, together with some extra planning and administrative expenses, and offset by the increase in farebox revenue from traffic growth in response to the service change. Despite the large amount of documentation about the Atlanta program, there has been minimal published attention to the costs, however. Ignoring the incremental planning and administrative expenses (which were probably relatively small), calculations in Appendix B suggest that the net costs to the property were on the order of \$1.45 million over the first year, or \$2.84 million in 1980 dollars. Over a five-year program period, the discounted annual cost averaged \$2.42 million (at 1980 prices): this represents \$1.68 per additional ride. Since the full demand response to the supply expansion was probably not experienced within the first year, however, this average cost is likely to be an overestimate.

Table G6.3 provides summary assessment measures for the Atlanta program.

Alternatives

Since the income distributional implication of the Atlanta program was the prime motivating factor, alternative policies would need to

Table G6.3: SUMMARY ASSESSMENT FOR THE ATLANTA PROGRAM

Demographic Characteristics	
Population of service area, 1972	1,053,400
Area of service area (square miles)	799
Mean density (persons per square mile)	1,318
Median annual family income, 1969	$10,500

	fare reduction	first year bus miles increase (Millions)	overall
Program Characteristics (Annual)			
Additional linked trips	5.76	1.41	7.18
User benefits	16.4	4.37	20.8
VMT reduction	n.a.	n.a.	35.7
Program cost	$14.5	$2.42	$17.0
Performance Measures			
Program cost per trip	$2.52	$1.72	$2.36
Program cost per VMT reduced	n.a.	n.a.	0.47
Program cost per dollar of user benefit	0.89	0.55	0.82

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips and VMT reductions) are present values obtained by using a 10 percent discount rate over a five-year program period.

have the potential to redress the probable regressive effects of the sales tax method of financing. A user-side subsidy scheme, under which pre-qualified members of the population could purchase bus tickets at a reduced price, would be well worth considering under these circumstances -- although such a scheme has yet to be tried in a US city as

large as Atlanta, and in 1972 the concept had not been much tested even in much smaller cities. Another major category of alternative policies designed specifically to help the lowest income groups would be to target intensive service improvements to better serve the travel demands of such people. Whether either of these approaches would have been as politically effective as the low fare plan is a matter for conjecture.

Turning to the transportation outcomes of the program, the particular fare reduction and service enhancement combination which was used in Atlanta could be compared with several other plausible fare and service combinations. This case study provides some clues as to what alternative policies might be worth considering. First, the increase in bus miles "bought" a given number of additional trips at roughly 60% of the cost of the trips "bought" by the fare cut. Secondly, the time series ridership model used as the basis for this analysis suggests that, in terms of the ridership impact observed over the study period, each 1 million extra bus miles operated per year was roughly equivalent to a fare reduction of 2.7 cents. This implies the supply would have had to be increased by roughly 9 million bus miles per year -- almost half of the existing volume -- to have a similar ridership response as the 25 cent fare cut. And finally, MARTA interpreted the responses from the on-board survey as suggesting that a smaller fare reduction from 40 cents to a new base fare of 25 cents would have achieved over 80% of the ridership gain from the 15 cent fare.

While such observations can provide useful rules of thumb for deciding what types of alternative fare/service packages are worthy of consideration to achieve particular transportation outcomes being sought, they must be used circumspectly. A 50% increse in bus miles, for instance, is far outside the range of experience used to calibrate the time series patronage model, and appraising such an option should require additional analysis. Calculations of the costs would also be more complicated because of the need to include the amortized capital costs of the necessary bus fleet (and perhaps garaging facilities) expansion.

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Case Study G7: The Hopkins Shared-Taxi Program

Hopkins, a suburb adjacent to Minneapolis, has a population of about 13,500 persons living in a small area of about 4 square miles. It contains an industrial area with four large firms. The regional transit agency operates several routes through the city and three or four taxi companies provide 24-hour service. In September 1978, the city used funding from a state demonstration program to initiate a new shared-ride taxi service called Hop-a-Ride. Users must call in 24 hours before traveling and subscription service for recurring trips is encouraged. Hop-a-ride operates within the city limits Monday through Saturday from 6:00 a.m. to 6:00 p.m. Almost all of the users purchase 10-ride ticket books from the city. These books cost until January 1980, when the price was increased, $5.00 to $8.00. The city allows certain low income persons to buy books for half price; about half of the books sold are discounted.

City personnel administer the program and are responsible for marketing, ticket sales, contract payments, financial records, and monitoring the service. Initially, the city contracted with a taxi operator to provide the service on a cost per service hour basis. In June 1980, the city changed the method of subsidizing the services to a user-side mechanism. Under this new arrangement the user still purchases tickets from the city and gives them to the provider, but now the provider redeems the used tickets for a specified amount from the city. The provider thus receives subsidies for the trips served rather than for the number of service hours operated. The city also encouraged other providers to participate in the program, but they declined, apparently because they have few vehicles in Hopkins.

Benefits

Ridership in the first year (1978-1979) grew gradually over the fall and winter months and totaled about 17,300 passengers for the year. During the second and third years, about 28,200 passengers used the service/1/. Ridership varies considerably from month to month, with highs in the winter and lows in the summer. Saturday ridership is very light.

On-board surveys conducted during 1979 and 1980 provide a user profile. The typical user is predominantly female, lives in a household with earnings less than $15,000 per year, and owns one motor vehicle. Tables G7.1 through G7.3 summarize the socioeconomic characteristics of the users and the travel impacts of the service/2/.

Almost half of the Hop-a-Ride users are traveling to or from work, with the rest traveling for medical, shopping, or social/recreational

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/1/ The Minnesota Department of Transportation, which continues to subsidize the service, monitors the monthly ridership and cost performance.

/2/ Based upon on-board surveys conducted in November 1980; 117 respondents.

Table G7.1: HOPKINS PROGRAM PARTICIPATION BY AGE GROUPS, 1980

	Percent in Population	Percent of Service Users (2,350 trips/month)
Age Group		
under 19	31	2
19 to 64	59	78
65 or older	10	20

Table G7.2: HOPKINS TRIPS BY PURPOSE, 1980

	Percent of Service Users
Trip Purpose	
Work	48
Shopping	16
Social/Recreation	12
Medical/Dental	17
School	4
Other	3

Table G7.3: TRAVEL BEHAVIOR IN ABSENCE OF HOPKINS PROGRAM, 1980

	Percent of Service Users
Alternative	
Auto passenger	26
Bus	26
Auto driver	23
Other (walk, carpool, no response)	13
No trip	7
Taxi	5

purposes. As shown in table G7.3, less than 10 percent of the users are making new trips as a result of the service. Over half of the users previously used an auto, about one fourth used a bus, and only 5 percent previously traveled by taxicab. Since the reductions in automobile and taxi travel are probably not large enough to off-set the increased VMT of the Hop-a-Ride service, the net effect is a slight increase in VMT.

Costs and Cost-Effectiveness

This project provides a comparison of the cost per passenger under a vehicle hours of service contract with that for a user-side subsidy approach. If we examine the 12 month period beginning six months after the service began (to allow for start-up and demand growth), the cost per passenger averaged $2.20 in 1980 dollars. Under the user-side subsidy, the cost per passenger dropped to $2.00 in 1980 dollars, about a 9 percent reduction. Beginning January 1981 the payment per passenger rose to $2.10, (only about $1.90 in 1980 dollars). The operator has an incentive to carry more riders in each taxi rather than dispatch another vehicle (and increase vehicle hours). With this change, the operator also saved considerable time (a reported 8-10 hours per week) preparing invoices for in-service hours based upon dispatching records. Now the operator just counts and submits the used tickets for payment.

For a city establishing this service in 1980 with a user-side subsidy mechanism, the start-up costs would be approximately $4,800 (inflating the $4,200 marketing expenses incurred in 1979). The annual marketing costs in 1980 dollars in the following years would be about $2,400. The annual administrative costs would be about $5,900 (inflating the 1979 costs), and the operating costs would correspond to the $2.00 per passenger value experienced in Hopkins in 1980. Assuming a first year ridership of 17,300 passengers and a level of 28,200 for subsequent years, the average cost per trip over a five year program period would be $2.35 in 1980 dollars, the average revenue per trip 40 cents, and the net program cost per trip $1.95. For an average trip length of 1.5 miles,the overall cost per passenger trip mile would be $1.30. The summary assessment measures for Hopkins are provided in table G7.4.

Alternatives

Service during rush hours could be operated and marketed on a subscription basis for regular commuters. The current 24-hour advance reservation requirement could be changed to allow more immediate service during the non-rush hours. A new fare structure also could be developed to reflect the type of service, with the price for immediate travel somewhat higher than for the pre-planned travel. Efforts also could be made to facilitate convenient transfers between the dial-a-ride and the regional bus service, including allowing the users to pay only one fare when boarding either service. While these changes

could stimulate more ridership, their effects on operating costs are uncertain. Some costs probably could be saved by ending the little used Saturday service and by reducing the time spent by city administrative personnel.

Table G7.4: SUMMARY ASSESSMENT MEASURES FOR THE HOPKINS PROGRAM

Demographic Characteristics	
Total Population (1970)	13,500
Area (square miles)	4.0
Average Density (person/square mile)	3,375
Program Characteristics (Annual)	
Trips Served Per Year	21,300
Program Cost Per Year	$41,535
Performance Measures	
Total Cost Per Trip	$2.35
Total Revenue Per Trip	40 cents
Program Cost Per Trip	1.95
Program Cost Per Trip Mile	1.30

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

Reference

The Minnesota Department of Transportation, Office of Transit Administration, in St. Paul, Minnesota, provided monthly ridership and cost information for the period 1978 to July 1981.

Case Study G8: The Jacksonville Bus Fare Increase

A fare increase on the Jacksonville (Florida) Transportation Authority (JTA) bus system occurred October 1978. The fare increase, the first for the system in five years, changed the adult base fare from 25 cents to 35 cents, weekly pass prices from $5 to $7, and monthly passes from $10 to $14. Children's cash fares, student tickets, elderly and handicapped fares, and special beach route fares also experienced increases, and special passes for students and the elderly were abolished.

Time series patronage data for a period spanning this fare change have been analyzed independently by Charles River Associates, Inc. (1980) and by Wang (1981), and this case study draws on the CRA ridership model. For simplicity, we compare the average situation over the twelve month period preceding the fare change with averages for the twelve months after the change. One should note that the use of a time series patronage model makes it possible to perform similar calculations on a month to month basis to derive more detailed estimates.

Loss of Benefits

The volume of originating trips made on the system per month over the year preceding the fare increase averaged 1.28 million. Over the twelve months after the increase, the corresponding figure was 1.23 million per month, a fall of about 4%. In comparing the two periods, however, several other changes need to be taken into account. There was a small increase (roughly 2.8%) in the number of bus miles operated between the "before" and "after" periods, and gasoline prices increased by over 8% on average. In addition, the system was experiencing a long-term secular decline in patronage.

The separate influences of these various factors can be judged from a regression model using time series operating data, as detailed in Appendix C. Calculations suggest that, if the "external conditions" (gasoline prices and the secular trend) are held constant at their "after" values and the level of supply is held constant at its "before" value, then the ridership change attributable to the fare increase alone is from 1.27 million per month to 1.20 million, a loss of almost 6%.

If we assume for comparative purposes that this ridership response would continue steadily into the future, the mean ridership change averaged over a five-year program period and discounted was a loss of 0.74 million originating trips per year. To produce cost-effectiveness measures which are comparable with those for other case studies (which have assumed no changes in their background effects), we have adopted this assumption in computing all of the five-year averages shown here. It is interesting to note, however, that these figures differ quite a lot from those which are obtained when one uses the model to project the actual likely outcomes in Jacksonville over the five-year period following the fare increase. (See Appendix C also.) Then one obtains

a five-year average (discounted) ridership loss of 1.05 million, somewhat higher than the loss of 0.74 million. This difference reflects projected changes in gasoline prices and general inflation over the five-year period which the patronage model predicts will magnify the ridership difference between the old and new fares, supply level remaining constant.

The estimated loss of user benefits as a result of the price increase was calculated (in 1980 prices) as $1.29 million for the first year and $1.07 million averaged over a five-year period. This loss will be slightly offset by a probable improvement in service quality for the riders remaining on the system. At a constant supply level, lower ridership is likely to mean increased comfort and possibly slightly improved travel times, but we have no data to value these (probably quite small) effects.

Since no data exists on how many of the trips lost from the bus system were subsequently made by other modes, the implications of the fare increase for total VMT cannot be estimated.

Costs and Cost-Effectiveness

The revenue gain to the transit system ascribable to the fare increase alone was (in 1980 dollars) $0.96 million over the first year and $0.80 million when averaged over a five-year program period. Table G8.1 summarizes the impacts of the program.

Alternatives

Faced with a need to balance the budget, the across-the-board fare increase proposal could have been compared with selective service cutbacks, or alternative fare structure changes which might have produced comparable revenue gains at a lower ridership loss. Examples of the latter include distance-based fares and peak/off-peak fare differentials/1/. Unfortunately, we typically do not know enough about the demand response among particular market segments to investigate and appraise such policies well.

/1/ Cervero, et al (1980).

Table G8.1: SUMMARY ASSESSMENT FOR THE JACKSONVILLE FARE INCREASE

Demographic Characteristics	
Population of service area, 1975	580,000
Area of service area (square miles)	800
Mean density (persons per square mile)	725
Median annual family income, 1969	$8,669
Program Characteristics (Annual)	
Trips lost per year	740,000
User benefit reduction per year	$1,070,000
Revenue gain per year	$800,000
Performance Measures	
Revenue gain per trip lost	$1.08

Note: Costs are expressed in 1980 dollars, and all costs and benefits (including trips and user benefits) are present values obtained by using a 10 percent discount rate over a five-year program period.

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Case Study G9: The Johnson County Replacement of Regional Transit Authority Bus Service with Private Provider Service

Johnson County, Kansas, a suburban area southwest of Kansas City (Missouri), had about 270,000 residents in 1980 (in an area of 476 square miles). With the fastest-growing population in the metropolitan area, the county in 1980 also had the highest per capita income, the lowest proportion of poverty level families, and the most highly educated population.

Until 1982, Johnson County, like seven other suburban jurisdictions, contracted with the Kansas City Area Transportation Authority or Metro for bus services using annual "Purchase of Service Agreements." The amount each locality pays Metro is determined on the basis of four allocation procedures. First, the operating costs and the passenger revenues are imputed to routes and the jurisdictions served by them to determine the deficits by jurisdiction. Then to offset each community's deficit, a share of Metro's federal operating assistance (Section 5 funds) is allocated to each community. Finally, each jurisdiction contributes a "capital levy" per bus mile operated, to finance the local share of new capital. A comprehensive description of these procedures, together with a discussion of the allocation issues has been prepared by Kemp (1982).

In 1980 Johnson County solicited bids for scheduled fixed-route service on six intracounty lines, and for express and local bus service on seven lines into Kansas City, Missouri. The latter seven lines were being served by Metro at the time. The county selected a private bus company to operate the new intracounty services in 1981, but decided to continue on with Metro for another year on the other lines, even though Metro's bid was not the lowest one received.

By mid-1981, the county commissioners and staff became so dissatisfied with the Metro arrangement that they again requested bids to operate the seven lines into Kansas City, Mo. during 1982. County personnel have expressed four main reasons for the dissatisfaction with Metro:

- the revenue allocation procedure and out-of-date ridership data did not credit the county its proper revenues;
- some of the cost allocation policies (and the high deadhead mileage cost because Metro vehicles were not garaged within the county) increased the costs charged to the county;
- Metro service quality, particularly reliability and air conditioning, was deteriorating; and
- unhappiness with the politics of the regional compact, and in particular the strong influence of Kansas City, Mo., was growing.

In the fall of 1981 the county obtained four bids for the Kansas City service. Metro's bid of about $1.2 million was considerably higher than bids from three private bus companies which ranged from $720,000 to $890,000. The lowest bid (made by the same company that was operating the intracounty services) averaged about $1.32 per bus mile compared to Metro's bid of about $2.68 per mile.

The county staff appraised the four bids by estimating the 1982 costs to the county. The total revenues were assumed to be $400,000. If Metro operated the services, the passenger revenues credited the county would be only $322,000 of the $400,000, although $438,000 of Metro's federal operating funds would also be credited to the county. With these assumptions, the county estimated a net annual savings of about $115,000 for the low bid compared with continuing with Metro's services, even though this meant foregoing the federal funds.

This case study describes the ridership and cost impacts associated with the February 1982 change from services provided by the regional authority to services operated by a private bus company/1/. It is difficult to isolate the effects due to the alone change in providers because of the aggregate nature of Metro ridership and cost data. In addition, bus ridership systemwide and in Johnson County appears to have been declining during 1981 and 1982 due to several influences such as the national economic recession, stable gasoline prices, some small service reductions, and a Metro fare increase in January 1982. For this case study, we have made several assumptions to compare what happened in 1982 with the private operation to our projections of what would have happened in 1982 if Metro had continued to provide the service.

Loss of Benefits

The estimated impact on Johnson County bus ridership into Kansas City due to the change in providers (and a degradation in the local services into the City) was minimal--total ridership was only 5 percent below our forecasted ridership for Metro service (Table G9.1).

While the county intended for the new operator to provide the same scheduled service as Metro, Kansas City, Mo. did not permit the local services, which had previously operated to the central business district, to continue into the city. (The peak-hour express services were allowed to continue operating through the downtown.) A Johnson County resident using the local services to downtown Kansas City now must transfer to Metro routes just over the city border. Johnson County riders on the new service, however, did not experience higher fares until August 1982, whereas the Metro system fares went up January 1982.

Cost Reductions and Cost-Effectiveness

Our estimates of the total operating costs, passenger revenues, and net subsidies for Metro services to the county in 1981, our Metro projections for 1982, and the actual costs with the private operator in 1982 are shown in Tables G9.2 and G9.3. The total costs charged to the county for bus services in 1982 declined 30 percent (about $320,000) compared with the Metro charge for 1981. After crediting passenger revenues, the total deficit declined about 40 percent (about $315,000) compared to the Metro deficit for 1981.

The net county costs, in 1982, however, went up by 27 percent (about $101,000) when compared to 1981 because the county's share of federal

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/1/ Based upon Kemp (1982).

Table G9.1: ESTIMATED RIDERSHIP IMPACTS DUE TO PROVIDER CHANGE

	Annual Revenue Passenger Trips (thousands)	
Estimate for provision by Metro, 1981	493*	
Project 1982 ridership, had Metro continued to operate the service	421+	
Estimate for provision by private firm, 1982	400#	
1982 ridership change ascribed to change in providers alone	-21	(-5%)

Notes: * Metro reported 594,000 passenger trips in 1981, based upon allocated revenues and an outdated revenue per passenger estimate of \$.39 for the first seven months and a revised estimate of \$.54 for the last five months. We have assumed that the \$.54 was valid for the full twelve months, resulting in an estimated 493,000 passenger trips.

+ Assuming Johnson County Metro ridership would have decreased 15%, about the same decline as for the entire Metro System in 1982. (Metro fares also increased in January 1982.)

We estimate a total private provider ridership for 1982 of 391,000 passengers (annualized to represent a full 12 months' service by the private firm), but this included five months with a fare increase. Assuming no fare change for the purposes of this comparison, we estimate ridership of 400,000 passengers for 1982.

operating assistance (about \$486,000 in 1982) was reallocated to the remaining jurisdictions served by the authority. If the county would have continued with Metro in 1982, we estimate the net county costs (after crediting \$486,000 in federal funds) would have been about \$487,000. Thus, Johnson County's decision not to purchase Metro services in 1982 saved about \$17,000 in the first year.

The other communities also had to share in an increase in Metro costs due to the Johnson County defection. (See Table G9.3.) This indirect cost assessment, which covered Metro overhead, administration, and maintenance expenditures, was about \$625,000 in 1982. Due to the Metro federal subsidy allocation procedures, the suburban communities had to increase their payments about 5 percent to cover these new costs. Kansas City, Mo., on the other hand, may have saved direct operating costs on the Johnson County lines. Because it received most of the Johnson County federal allotment, Kansas City, Mo. may actually have reduced its 1982 payment to Metro!

Table G9.2: COST AND REVENUE IMPACTS FOR JOHNSON COUNTY (IN THOUSANDS OF DOLLARS)

	1981 Metro operation	1982 Metro operation*	1982 private operation	change amount	change %
Financial Impact on Johnson County					
costs billed to the county	1,050	1,200	730#	-470	-39
revenues credited to the county	265	227	260	+ 33	+15
deficit on county services	785	973	470	-503	-52
federal subsidy allocated to county	460	486	-	-486	-100
net cost to the county	369+	487	470	- 17	- 3

Notes: * The second column projects the situation had Metro continued to operate the services (without a fare increase) in 1982. The third column provides estimates of the private provider's performance in 1982 if (i) the firm had provided service for the full year, and (ii) there were no fare increase.

\# This figure includes payments to the private firm and other expenses incurred directly by the county (vehicle licences, additional insurance, information services, etc.)

\+ Includes a $44,000 levy for capital expenses

If the Johnson County change in providers were made on a 1980 base year, the first year total cost savings (in 1980 dollars) would be $1,016,000 (deflating the projected Metro 1982 cost of $1,200,000) less $618,000 (deflating the actual Johnson County cost of $730,000), or $398,000. This also would be the assumed cost savings in subsequent years. If we assume that the projected ridership in 1982 with Metro would have been about 421,000 passengers and it was about 400,000 passengers with the new provider, then the ridership loss would be 21,000 passengers in the first and subsequent years. Similarily, the first year change in passenger revenues (in 1980 dollars) would be $220,000 (deflating the actual $260,000 Johnson County revenue, assuming no fare increase) less $192,000 (deflating the projected Metro 1982 revenues of $227,000, again assuming no fare increase), or $28,000 per year. This also would be the revenue gain in subsequent years. Taking the present values over a five-year program period produces the revenues shown in Table G9.4.

The replacement of a regional transit authority with a private provider in Johnson County has resulted in a substantial cost reduction for county bus service into Kansas City. The county saved a small amount of money in the first year and believes it can control its service quality and costs better.

Table G9.3: COST AND REVENUE IMPACTS FOR METRO (IN THOUSANDS OF DOLLARS)

	1981 Metro oper- tion	1982 allocated to the service*	1982 change from ceasing service*	reallocated to other other Metro services
Financial Impacts on Metro:				
total operating costs	1,400	1,600	-975	625
total revenues	329	281	-281	-
total deficit	1,071	1,319	-694	625

Notes: * The second column projects the total costs and revenues which Metro's procedures would have allocated to the Johnson County services in 1982 (absent a fare increase). The third column estimates the annualized change in costs and revenues from curtailing the service.

In the future the county does not have to meet any federal regulations that go with the operating assistance and federal operating funds may also decline or be phased out. In early 1983 other suburban jurisdictions were considering contracting with private operators for Metro provided services.

Alternatives

An alternative to contracting with private providers would be for the county to operate the service, as has been done in a suburban Maryland county (See Case study G11).

Another possibility is to have the regional authority be a coordinating agency that selects different providers for different areas or types of services and then channels local and federal funds to pay each provider. This agency also could coordinate services to insure integrated service and fare policies. The regional transit authority in Norfolk (See Case Study G4) and other transit agencies have assumed this type of funding and coordinating function. Transit labor unions, however, generally oppose countracting to non-union providers and the federal labor protection provisions may inhibit a transit authority's ability to fund private providers.

References

Kemp, M. (1982). "Financing Interjurisdictional Bus Lines: The Kansas City Situation." Urban Institute Working Paper 3124-1. Washington, DC: The Urban Institute.

Table G9.4: SUMMARY ASSESSMENT FOR THE JOHNSON COUNTY REPLACEMENT OF METRO BUS SERVICE

<u>Demographic Characteristics</u>	
Total Population, 1980	270,000
Per Capital Income, 1979	$12,000
<u>Program Characteristics (Annual)</u>	
Trips Lost Per Year	17,500
Operating Costs Saved Per Year	$332,000
Revenues Gained Per Year	$23,300
<u>Performance Measures</u>	
Operating Costs Saved Per Trip Lost	$18.98
Revenues Gained Per Trip	1.33
Net Costs Saved Per Trip Lost	20.31

Note: Costs and revenues are expressed in 1980 dollars, and all costs and trips are present values obtained by using a 10 percent discount rate over a five-year program period.

Case Study G10: The Memphis Bus Fare Increases, Service Reductions, and Route Restructuring

The Memphis Area Transit Authority (MATA) provides bus service primarily with the City of Memphis (Tennessee), an area of 288 square miles with a 1980 population of over 646,000 people. Located on the east bank of the Mississippi River, the city's development has been to the east, southeast, and northeast. In the past few years, major efforts have been made to revitalize the central business district, situated adjacent to the river. Although bus ridership had been declining between 1964 and 1976, between 1976 and 1980 MATA's efforts increased ridership by about 60 percent to around 24 million passengers per year. While transit ridership grew, annual operating costs and deficits also grew, requiring larger city and federal subsidy funds each year. The 1976 base fare of 50 cents was raised to 60 cents in July, 1979, and to 70 cents in September, 1980.

In late 1981, as MATA was preparing its FY82 budget, the City of Memphis declined to increase its operating subsidy (which covered about 25 percent of total operating expenses). The proposed phase-out of federal operating assistance (which covered about 27 percent of the operating expenses) also reduced the funds expected in FY82. The state provided almost no operating subsidies. Facing restrictions on operating assistance, MATA began to make a series of fare and service changes designed to reduce costs and maximize revenues. The ATE Management and Service Company, which manages MATA operations, made a number of proposals to the transit union to reduce labor costs and increase driver productivity. However, the union would not consider any changes to the existing contract, due to expire in June 1983. According to management, the binding arbitration provision in the contract has resulted in the union's unwillingness to address major cost issues.

During a 14-month period, MATA took several actions to reduce operating costs and increase passenger revenues:

- In February 1981, vehicle service hours were reduced about 5 percent.
- In September 1981, the base fare was raised to 75 cents and vehicle service hours were reduced about 17 percent.
- In January 1982, the base fare was raised to 85 cents.
- In April 1982, the entire route system was restructured, vehicle service hours were reduced almost 28 percent, and vehicle miles were cut about 35 percent.

During these changes, the objective was to minimize ridership (and revenue) losses and to improve driver and vehicle utilization. Low ridership routes were dropped, off-peak headways were increased, and late evening and Sunday services were discontinued. All routes circulating through lower density areas were cut back or moved to major thoroughfares. These changes gave the scheduler an opportunity to improve driver assignments through careful run cutting and to significantly reduce the costs of drivers working off the extra board.

This case study describes the ridership and cost impacts associated with

the major fare and service changes during 1981 and 1982, with particular focus on the effects of the system restructuring of April 1982. The effects cannot be described in much detail, however, because only system-wide revenue, ridership, and cost data exist/1/. In addition, because several major fare and service changes have occurred over a relatively short period, and because the national economic recession effected Memphis severely during this period, it is impossible to identify the impacts of individual changes.

Loss of Benefits

The cumulative impact on bus ridership of the two fare increases and two service changes made during the eight-month period (September 1981 to April 1982) was dramatic--total annual patronage dropped 28 percent while revenues fell 9 percent (Table G10.1). Ridership appeared to have stabilized by October 1982 (about 7 months after the system restructuring).

Table G10.1: SYSTEM RIDERSHIP BEFORE AND AFTER FARE AND SERVICE CHANGES

	Unlinked trips	
	(millions)	
Before the Changes, FY81	23.8	
After the Changes, FY82	17.2	
Change in Ridership	-6.6	(-28%)

Note: Over 20% of the passengers made transfers.

According to MATA, peak and off-peak riders did not respond much differently across the system. User surveys indicated that 75 percent of the riders in the early 1980s used transit because they did not have access to automobiles for their trips. Although the elderly accounted for 15 percent of the ridership and students accounted for between 15 and 20 percent, the available information does not indicate how these groups' usage has been affected.

Riders who previously traveled on Sundays, holidays, or after 7:00 p.m. on evenings have not enjoyed bus service since April of 1982. Riders on

/1/ The primary source of information was the MATA monthly "Report on Operations" covering the period July 1980 to September 1982.

Saturday and during the off-peak on weekdays must wait longer for a bus, and transfer more often (although over 20 percent of all users transferred before the changes). Many of the current users have to walk greater distances to and from bus stops, and all riders have to pay higher fares.

Cost Reductions and Cost-Effectiveness

The cost and revenue levels reported by MATA for the fiscal years 1981 and 1982 before and after the changes are shown in Table G10.2.

Table G10.2: SYSTEM REVENUES AND OPERATING COSTS BEFORE AND AFTER FARE AND SERVICE CHANGES

	Annual Amounts ($ millions)	
	Revenues	Operating Costs
Before the Changes, FY81	8.7	19.8
After the Changes, FY82	7.9	18.8
Change	-0.8	-1.0
Percent Change	-9%	-5%

If the MATA changes were made on a 1980 base year, the first year cost savings (in 1980 dollars) would be the 1980 base year cost of $19.8 million less $17.0 million (deflating the 1981 cost of $18.8 million), or $2.8 million. The cost savings (in 1980 dollars) in the second and subsequent years would be the 1980 base year cost of $19.8 less $12.6 million (deflating an assumed total cost for 1982 of $15.0 million), or $7.2 million. If the 1980 base year ridership level were 23.8 million passengers, and we assume that the first year ridership change is due entirely to the system fare and service changes, then 6.6 million trips were lost in the first year. Assuming that ridership then stabilizes at 15 million, the number of trips lost in the second and subsequent years is 8.8 million. Similarly, if 1980 base year revenues are $8.7 million and the first year revenues are $7.1 million (deflating the $7.9 million revenues in 1981 dollars), the first year revenues lost are $1.5 million. Assuming the second and subsequent year revenues stabilize at $7.1 million (in 1980 dollars), then the subsequent revenues lost per year are $1.6 million (in 1980 dollars). Taking the present values over a five-year program period produces the measures shown in Table G10.3.

Table G10.3: SUMMARY ASSESSMENT FOR THE MEMPHIS FARE AND SERVICE CHANGES

Demographic Characteristics	
Total Population, 1980	646,000
Service Area (Square Miles)	288
Average Density (Persons/Square Mile)	2,243
Median Annual Family Income, 1969	$8,646
Program Characteristics (Annual)	
Trips Lost Per Year	6,900,000
Operating Costs Saved Per Year	$5,100,000
Revenues Lost Per Year	$1,300,000
Performance Measures	
Operating Costs Saved Per Trip Lost	74 cents
Revenues Lost Per Trip Lost	19 cents
Net Costs Saved Per Trip Lost	55 cents

Note: Costs and revenues are expressed in 1980 dollars, and all costs and trips are present values obtained by using a 10 percent discount rate over a five-year program period.

Alternatives

Faced with overwhelming budget pressures, MATA could have compared across-the-board fare increases and large-scale service reductions with alternative fare structure changes and lower cost ways to provide services (such as taxicab feeder services in lower density areas). A new fare structure such as distance-based fares or peak/off-peak differentials might have produced comparable revenue gains at lower ridership losses.

MATA made proposals to the labor union to reduce driver and maintenance costs. Several options were discussed including a wage freeze, changes in employee benefits, and work-rule concessions. Unfortunately, the union did not accept any changes even though over 25 percent of the drivers were to lose their jobs because of the service cuts.

Rather than assuming all service hours cost the same, MATA could have have developed cost information by route and time period/2/. Such information might have permitted MATA to cut services more selectively, thereby reducing the ridership losses associated with a given level of cost reduction.

References

Cherwony, W.; Gleichman, G.; and Porter, B. (1981). "Bus Route Costing Procedures, Interim Report No. 1: A Review" Report No. UMTA-IIT-07-9014-9101. Washington, DC: U.S. Department of Transportation.

/2/ Cherwony et al. (1981).

Case Study G11: The Silver Spring Ride-On Transit System

The Silver Spring Ride-On, a county operated small bus system, serves two densely populated suburban Maryland communities, Silver Spring and Takoma Park, just to the north of Washington, D.C. The service area contains about 77,000 people and covers about 6.5 square miles (an average density of 11,850 persons per square mile). The Silver Spring CBD, a major retail center, has about 120 employers and approximately 10,000 workers. Other public transportation options in these communities include: regional bus routes primarily oriented to Washington, D.C., taxicab services, and several county and privately operated human service transportation programs.

In April 1975, the Ride-On began with twelve 19-passenger buses operating on two loop routes. In August 1976 it expanded to 20 buses operating on four routes which converged at a central point every 20 minutes. Buses operated Monday through Saturday from about 7 a.m. to 7 p.m. The fare was 25 cents with free transfers; children under 40 inches in height rode free. The Ride-On system has continued to expand. In 1978, when two regional rail transit (Metro) stations opened, it became a major feeder to the stations operating 48 buses on over twenty routes/1/. This case study examines the initial three year phase (1975-1977) when the system was primarily a community oriented service/2/.

The county considered using federal capital and operating assistance, but decided that the associated labor protection and other requirements would increase the implementation time and total costs while limiting local flexibility and control over service and fare policies. The Ride-On was funded by Montgomery County and operated by the county Office of Transportation Planning, with different county departments providing vehicle maintenance, and administrative functions such as personnel hiring, insurance, and purchasing.

Benefits

Ridership grew rapidly and averaged over 14,000 paid passenger (transfers and small children excluded) per week after 16 months. With the service expanded to four routes, ridership continued to grow and after 12 months exceeded 19,000 passengers per week. Tables G11.1 through G11.3 present an age profile of users and the travel impacts of Ride-On based upon an on-board survey conducted two months after the service expansion. In all of the tables weekday travel is shown to differ from Saturday tripmaking. Table G11.1 shows that the age profiles of the users do not differ greatly from that of the general population. Shopping is the major trip purpose on both weekdays and and Saturday, but work and school travel dominate during weekdays. As shown in Table G11.3, about 7 to 10 percent of the riders are

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/1/ See Division of Transit Services (1980).

/2/ See Office of Transportation Planning (1976) and (1977).

Table G11.1: RIDE-ON PARTICIPATION BY SOCIOECONOMIC GROUPS

	Percent of Total Population	Percent of Trips Friday	Percent of Trips Saturday
Age Group			
Under 16	22	11	13
16-20	16	24	17
21-60	52	57	59
Over 60	10	8	11

Table G11.2: RIDE-ON TRIPS BY PURPOSE

	Percent Friday	Percent Saturday
ɪrip Purpose		
Work	27	13
Shopping	38	71
School	21	4
Other	14	12

Table G11.3: TRAVEL BEHAVIOR IN ABSENCE OF RIDE-ON

	Percent Friday	Percent Saturday
Alternative		
No trip	7	11
Automobile	10	7
Taxi	15	20
Regional Bus	35	34
Walk	26	24
Other/No Response	7	4

making new trips and about the same percentages previously traveled by automobiles. Over one-third previously used the regional bus service, and about 13% of all riders still transferred to the regional bus. Fifteen to 20 percent previously used taxicabs. Since the reductions in automobile and taxi travel are not large enough to off-set the additional VMT of the Ride-On, total VMT increases.

Costs and Cost-Effectiveness

During the first 12 months (1975-1976) the estimated costs were $45,000 per month, which included vehicle depreciation of $400 per bus per month and county charges for maintenance. The costs of an eight-month pre-operational planning phase and administrative support expenses such as personnel hiring, insurance, data processing, and purchasing are not included. (Separate cost information on the marketing activities and several "free" days is not available, but their costs are included.)

For a public agency instituting a program like the Ride-On in 1980, the cost per month for the two route system in the first year would be about $69,000 (inflating the $45,000 monthly costs incurred in 1975-76). The 1980 costs for a four route system in the second year would be about $96,000 per month (inflating the estimated $63,000 monthly cost in 1975 dollars of a 40% expansion in bus miles and hours). Assuming a first year ridership of 585,000, 910,000 in the second year, and 1,010,000 in succeeding years, the average total cost per trip over a five-year program period is $1.21 in 1980 dollars; the revenue per trip is 38 cents and the net program cost per trip is 83 cents. Assuming an average trip length of 2 miles, the program cost per passenger trip mile is 42 cents. The summary assessment measures are shown in Table G11.4.

Alternatives

The Ride-On service was quite successful and, as mentioned previously, the county has expanded the program considerably. In terms of cost-effectiveness the Ride-On program cost per passenger of 83 cents (in 1980 dollars) is impressive when compared to an estimated subsidy cost per passenger (not including capital costs) of over $1.00 for the regional bus service in the county. Most of the county's regional bus users, however, are commuters traveling into D.C. while the Ride-On users are multipurpose,intra-community travelers.

An alternative to the county directly operating the service is contracting with private providers or, perhaps, the regional bus operator. The county could still own the vehicles and lease them to one or more operators who could bid for providing services on all or some of the various routes.

Table G11.4: SUMMARY ASSESSMENT FOR THE SILVER SPRING PROGRAM

Demographic Characteristics	
Total Population (1970)	77,000
Area (square miles)	6.5
Average Density (persons/square mile)	11,850
Median Annual Family Income, 1969:	
Silver Spring	$14,600
Takoma Park	$11,100
Program Characteristics (Annual)	
Trips Served Per Year	739,000
Program Cost Per Year	$615,200
Performance Measures	
Total Cost Per Trip	$1.21
Revenue Per Trip	38 cents
Program Cost Per Trip	83 cents
Program Cost Per Trip Mile	42 cents

Start-up, some administrative, and insurance costs not included.

Note: Cost are expressed in 1980 dollars, and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period.

References

Office of Transportation Planning (1976). "TESS Loop Minibus System Report on First 40-weeks of Operation," Rockville, Maryland: Montgomery County Department of Transportation.

Office of Transportation Planning (1977). "Silver Spring Ride-On Transit System 1976 Report," Rockville, Maryland: Montgomery County Department of Transportation.

Division of Transit Services (1980). "Silver Spring Ride-On: Community-Level Transit in an Urban County," Rockville, Maryland: Montgomery County Department of Transportation.

Chapter 6

AUTOMOBILE MANAGEMENT AND PRICING EXAMPLES

A GUIDE TO EXAMPLE PROGRAMS

This chapter describes programs which illustrate how the regulation and pricing of automobile use can either enhance the effectiveness of public transportation or achieve the same aims that public transportation addresses. Two case studies incorporate parking price increases for automobiles entering zones with traffic and parking problems. The first describes a program in Madison (Wisconsin) which applies peak-period parking surcharges at several city garages. The second describes a non-resident parking price program in a neighborhood adjacent to a beach in Santa Cruz County (California). The third case study, the Santa Monica Diamond Lane experiment in California, involved the designation of priority lanes for high-occupancy vehicles on the Santa Monica Freeway.

Preliminary assessments of the two automobile pricing programs illustrate that carefully designed automobile pricing programs--tailored to local conditions and needs--can bring significant relief from problems related to automobile use.

The Santa Monica Diamond Lane experiment illustrates some of the difficulties of trying to improve a major freeway corridor. While largely successful in improving public transportation service levels and increasing the overall corridor capacity, the project failed to bring about noticeable improvements in energy consumption or air quality. More importantly, congestion levels and accidents increased significantly for the large majority of the users who did not use the diamond lanes.

In assessing automobile use management programs the planner encounters a number of technical difficulties. In addition to the problems of predicting travel impacts, the planner must deal with multiple objectives, and assess a number of indirect and non-user impacts. Frequently in automobile pricing programs, the user impacts turn out to be negative, and the justification of the program must rest on the non-user impacts.

We have not discussed the many implementation hurdles faced during the evolution of these programs. The programs required long gestation periods and careful nurturing of supporting constituencies. As the planning progressed, many program elements had to be altered from the original ones in response to political concerns. The experience with these programs suggests that a significant amount of time and planning will be required to implement similar programs in other locations.

Exhibit 13 lists the major types of regulatory and pricing actions which might be considered as complementary actions to public transportation programs and provides key references on each type of action.

EXHIBIT 13: REGULATORY AND PRICING ACTIONS PERTAINING TO AUTOMOBILE USE

Type of Action	References
Priority Lanes for High-Occupancy Vehicles	Rothenberg and Samdahl (1981) Public Technology, Inc. (1977)
High-Occupancy Vehicle Priority/Signals or Ramps	Rothenberg and Samdahl (1981)
On-Street Residential Parking Restrictions	Olsson and Miller (1979) Simkowitz, et al (1978)
Auto Restricted Zones	Herald (1977)
Auto Free Zones	Koffman and Edminster (1977)
Road Pricing	Higgins (1978) Bhatt, et al (1976)
Parking Pricing and Supply Management	DiRenzo, et al (1981) Miller and Higgins (1983) Miller and Everett (1982)

Case Study A1: Madison Downtown Commuter Parking Surcharge Program

Madison, the state capital of Wisconsin, has an urbanized area population of approximately 200,000. The downtown covers part of an isthmus which runs about three miles from east to west between two lakes. The state capital, the county and city governments, and the University of Wisconsin are all located within about a mile of the center of the isthmus. The principal retail core surrounds the capital area and State Street, which runs from the capital to the university. About half of Madison's 120,000 person workforce is employed in the isthmus. The 1.5 square mile core employs about 45,000 people, and also continues to be an important residential area.

During the last decade new shopping malls in suburban areas have attracted a significant amount of retail activity away from downtown. However, the city has shown a keen interest in preserving downtown retail activity and the vitality of the central area in general. Transportation-related actions in the central area during the past 15 years include: the establishment of an auto-free shopping mall; residential preferential parking; and aggressive transit promotion and expansion. These actions and the existence of the University have contributed to heavy transit use for a city the size of Madison.

City planners have considered several innovative automobile management strategies aimed at decreasing dependence on the automobile. During the mid-1970s, Madison seriously considered a road pricing program for the downtown core along with significant transit expansion and promotion. All low-occupancy vehicles entering the core during the peak period would have been required to pay a daily charge. The proposal aimed to reduce commuter traffic and parking, and enhance the use of high-occupancy modes. Although this plan was rejected as too radical, the city nevertheless continued to pursue automobile disincentive policies, focusing on parking management instead of moving vehicles. Long-term parking charges in the downtown were increased in the mid-1970s. The peak-period parking surcharge program evolved from these efforts.

By the late 1970s, there appeared to be an acute shortage of mid-day parking spaces for shoppers in the core area. Of the 23,000 legal spaces in the core area, two-thirds were for private (employee) use. Of the 7,500 available to the public, 4,300 were off-street (largely in city-owned metered lots and garages), and 3,200 were metered on-street. Parking cost 20 cents per hour at the 3,600 off-street meters, and 25 cents per hour on-street. The on-street spaces near the capital, the State Street mall, and the university had a utilization rate of well over 90 percent. Most of the off-street public lots and garages were occupied by 9:00 a.m., and the overall parking utilization rate was over 95 percent. Only 13 percent of the municipal on- and off-street parking spaces were being used for short-term parking in 1978, despite the fact that 29 percent of them were set aside (through the use of time limits) for short-term parking. Thus, a large number of short-term spaces were being used by commuters who fed the meters periodically.

Under these circumstances, downtown retailers responded favorably to a proposal to charge commuters more for parking in the core. An UMTA demonstration grant was obtained to fund a program to encourage commuters to shift to high-occupancy modes, and thus free up parking spaces for mid-day shoppers.

The program included the following principal components:

- the conversion of five off-street municipal public parking facilities from metered to attended operation. A surcharge of $1.20 was applied to all vehicles arriving and parking between 6:30 a.m. and 9:30 a.m. at three of the off-street facilities. (The three facilities contained a total of 800 spaces, accounting for four percent of all downtown parking and 11 percent of all public parking downtown);

- establishment of fringe park-and-ride lots two to four miles from downtown with a low-fare shuttle bus service to downtown; and

- subsidized transit passes for a substantial number of downtown employees.

The attendant operation was designed to implement the parking surcharge, to enable parking ticket validation by merchants, and to inhibit commuters from "feeding" meters past the time limit. (The morning surcharge was originally proposed at all five off-street lots for a total of 2,000 spaces, but was eventually implemented at only three of the lots for a total of 800 spaces.)

The shuttle service and transit passes were implemented a year before the parking surcharge, and the surcharge was in effect for a period of six months from late December 1980 through June 1981. The program characteristics are summarized in Table A1.1.

Benefits

Preliminary data indicate that no measurable change occurred in shuttle ridership when the surcharge was implemented. Similarly, no measureable increase in carpooling or transit use was observed. The utilization of spaces at off-street parking facilities, however, was affected. The utilization levels at two of the three facilities (accounting for 600 of the spaces) remained at 100 percent. In contrast, the utilization level decreased at the third facility. Before the surcharge, all three facilities filled by 9:00 a.m. Afterwards, they did not fill up until late morning or early afternoon. Thus, the primary impact of the surcharge was to spread the use of available spaces to all five facilities around downtown, and to keep them from filling up so early.

The question of whether the surcharges encouraged mid-day shopping trips as a result of slightly improved parking availability cannot be answered until more data are available. These shopper benefits should be weighed against the possible disbenefits accruing to those who pay the surcharge, and to those who are forced to move to transit or other alternatives that were not their first choice.

Costs and Cost-Effectiveness

Some cost items, such as data collection and grant administration, were incurred because the program was implemented as a demonstration. Another locality instituting such a program would avoid these costs. Significant costs ($400,000) were also incurred in Madison to set up and operate the park-and-ride lots, the shuttle service, and the discounted transit pass program.

TABLE A1.1: MADISON PROGRAM DESCRIPTION

Zone Characteristics	
Zone size	1.5 square miles
Employment	45,000
Parking (total)	23,000
Private	15,500
Public Use	7,500
Typical charge in parking lot, 9-hour stay	$1.80
Program Features	
Parking Policy:	Arrival charge of $1.20 at 800 spaces between 6:30 and 9:30 a.m.
Collateral Actions:	Free parking at four park-and-ride lots located on the fringe of downtown, with low-fare shuttle bus service to downtown
	75 percent discount on transit passes to about 1,500 downtown employees

The preliminary data suggest very poor response to these elements of the program. These elements apparently were not cost-effective.

The costs to convert the five off-street facilities from self-parking to attended operations were also substantial. The physical improvements alone cost more than $300,000, including installation of gates, booths, and ramps. The incremental operating costs in 1981 were running at an annual rate of $180,000 for the five facilities. The additional revenues due to attended operations and the parking surcharge were estimated to be between $120,000 and $200,000. The revenues from the surcharge alone were running at an annual rate of about $80,000. These include the surcharge revenues from 800 spaces, and the estimated increase in collection from other meters resulting from the presence of attendants.

All in all, the program was running at a large loss due primarily to the heavy start-up costs, and the park-and-ride, shuttle bus, and transit pass components. In aggregate, it is doubtful that the benefits outweighed the costs in this program.

Alternatives

The surcharge could have been implemented on a larger number of public spaces. This might have encouraged greater shifts to high-occupancy modes instead of to the large number of space not subject to the surcharge. The revenues would have been greater and more mid-day spaces would have become available for shoppers. The revenues and other impacts could have been enhanced further by increasing the level of surcharge. Significant cost savings could have been realized through the elimination of attendants and the use of special permits to implement the surcharge, though this might have increased fraud and reduced revenues. The subsidized transit passes and park-and-ride shuttle elements could have been scaled back or eliminated. The planners in Madison also could have considered other types of differential parking charge schemes such as a rate structure that changes more than proportionately for longer durations of parking.

Reference

Charles River Associates (1982). "Madison Parking Pricing Demonstration Project," Draft Final Evaluation Report. Cambridge, Massachusetts: Transportation Systems Center.

Case Study A2: Santa Cruz County Non-resident Parking Price Program

Santa Cruz, located 75 miles south of San Francisco on the Monterey Bay, has several county beaches that are popular seaside recreational areas. A beachfront residential zone in the East Cliff/Live Oak area of the county (adjacent to the City of Santa Cruz) is the site of an automobile pricing program. The zone, about two square miles in area, has approximately 2,000 housing units and a population of 4,500. In the summer months this zone has been heavily used by non-residents going to the beach, resulting in severe street congestion, littering and vandalism of residential property, and an acute shortage of parking (often resulting in the illegal spillover of vehicles at curbside and on private lawns and driveways). Surveys in the mid-1970s suggested that on peak days nearly 1,000 cars parked in this zone in the vicinity of the beach, about two-thirds of which belonged to non-residents.

Under an UMTA demonstration grant, a non-resident parking price program was implemented within the target zone during the summer of 1981. The principal features of the 1981 program/1/ were as follows:

- non-residents wishing to park within the zone were required to purchase and display a $5.00 daily permit purchased at roadside county vans and at half a dozen retail establishments. The fine for violation was set at $25.00/2/.

- residents of the zone, their guests, and owners and employees of the businesses located in the zone were allowed to park on-street in the target zone by displaying yearly windshield permits issued either free of charge (for the first vehicle), or for a nominal charge (for additional vehicles).

- free shuttle bus service was operated from outlying parking lots to the beach and retailing areas.

The principal goal of this program was to reduce non-resident parking in a residential neighborhood, and provide an alternative mode of travel (park-and-ride shuttle bus service) for access to the beach. The program was designed to be financially self-sufficient: all program costs (administration, enforcement, and operation of the shuttle bus) were expected to be met from program revenues from resident and daily non-resident permit sales. The rationale was that those who created the problems in the first place (non-resident beach visitors) would also be the major contributors to the solution. The program features are summarized in Table A2.1.

Benefits

Unlike most other programs described in this casebook, user impacts are not the primary focus of this assessment because the intent was to generate

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/1/ These features pertain to the original program before some substantial changes were made in late summer of 1981 and for 1982.

/2/ This compares with typical fines of $10-15 in the adjacent areas.

TABLE A2.1: SANTA CRUZ PROGRAM SUMMARY (1981)

Zone characteristics	
zone size	2.0 square miles
households	2,000
population	4,500
Program features	
Parking Policy:	Residents and retailers: free annual permit Guest and employees: $10 annual permit Non-resident visitors: $5 daily permit Violations: $25 fine
Collateral actions:	600-car free park-and-ride lots 3 buses provided frequent free service from lot to beach and retailing areas

non-user (resident) benefits arising out of reduced parking and travel by non-residents. Benefits and cost-effectiveness of such programs should be judged in terms of how well the specific objectives of the program have been met. Since the program includes two major components (parking price disincentives for non-residents, and provision of park-and-ride and free shuttle service), it is difficult to separate the impacts of one from the other. The usage of shuttle service was very low, however, and for all practical purposes one could overlook its contribution to the impacts, and attribute all the changes to the parking price component.

Observations suggest that beach user parking was reduced considerably--between 40 and 60 percent. Approximately 100 daily non-resident permits were sold every day on the average during early weeks of the program/3/. In addition, approximately 100 cars were parked illegally every day in the zone. This suggests that the number of total non-resident beach user cars parked in the zone dropped to about 200 from the prior level of about 500--a significant reduction in parking. The daily revenues from the program amounted to approximately $500 from the sale of daily permits and $1,250 from citation revenues (assuming that only half of those cited for illegal parking would actually pay the $25 fine). Additionally, the program generated some revenues from the sale of yearly permits to the residents, their guests, and commercial establishments in the zone.

In contrast to the dramatic impact on the parking situation, use of the park-and-ride shuttle bus was quite low. Only about 100 cars parked in the

/3/ The sales peaked at 150 per day on weekends.

designated lots on weekends and only about 40 on weekdays. The ridership per bus averaged only three persons. This performance, while disappointing, might have been expected. Increasingly, the evidence from similar situations suggests that a shuttle service probably is not a good substitute for the private automobile, even where parking fees are fairly high/4/. In this program some fragmentary evidence suggests that former users are going to nearby beaches, or foregoing the trip to the Santa Cruz area altogether.

The impact on retail businesses within the zone cannot be assessed with the currently available data. Some merchants have complained about a drop in their sales. However, a preliminary review of their ledgers fails to support these claims.

The positive benefits experienced by zone residents must be weighed against the possible disbenefits experienced by other parties. The non-residents who were users of the zone prior to the program are the principal losers. Those who continue to park after paying $5.00 for the daily permit (or those who park illegally and face citations) may be much worse off now despite the fact that parking is easier for them to find and on the average they have to walk shorter distances. The other prior users now either use shuttles, go elsewhere, or have given up making the recreation trips altogether. They are all worse off than before the program began/5/. One can estimate the disbenefits to these original zone users as $1,750 per day/6/.

Retailers in the target zone claim to have lost some business because of the program. Should actual data support their contention, they would have to be included among the losers from the program. The other potential losers include residents and non-resident users of neighboring zones and beaches--impacted by spillover traffic from the priced zone. The level of negative impacts would depend upon prior conditions and will be negligible, for example, if these zones had excess capacity.

Costs and Cost-Effectiveness

For a new locality instituting such a program, the initial cost burden could be spread over a program period of, say, five summers. The yearly burden then would be approximately $50,000/7/. (For the Santa Cruz

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/4/ The Madison case study (A1) provides similar evidence.

/5/ Undoubtedly, a handful of shuttle bus users actually were attracted away from their autos instead of being forced out as a result of the parking charges. Though these people experienced positive benefits, the data suggest that there were very few of them.

/6/ Disbenefits = (price change)(prior trips + after trips)/2
= ($5.00)(500 + 200)/2 = $1,750
(This neglects the fact that those who were actually attracted to the shuttle realized net positive benefits.)

/7/ This is the annualized burden of $192,000 (as incurred by Santa Cruz) over five years, using a 10 percent discount rate.

demonstration over just two summers, the daily burden of $192,000 in initial costs would be approximately $875, assuming 120 days of operations each summer.)

Considerable savings over operating costs in Santa Cruz also would be realized by another city. Data collection needs would be reduced significantly. Some savings in information dissemination could also be realized. It is not unreasonable to expect that the continuing annual costs could be brought down to $200,000. (The average annual continuing cost of the Santa Cruz program is estimated to be approximately $230,000--a daily burden of $1,916 for a 120-day summer program.)

The overall total annual cost of a similar program would be in the range of $250,000 (in 1980 prices)--with a reduction possible if the shuttle bus service were curtailed/8/. The daily burden would be a little over $2,000 for a 120-day summer program. Revenues in Santa Cruz over the first month averaged approximately $1,800 per day ($500 from the sale of 100 daily non-resident permits; $1,250 from the 100 daily citations; and $50 from the sale of guest, employee, and other permits)/9/. Consequently, the net cost would be approximately $200 per day (running at an annual rate of $240,000 if revenue flow during the first month in Santa Cruz continued). In aggregate, this net cost must be weighed against the net benefits: clear and dramatic benefits for the zone residents, disbenefits to non-residents subject to the parking surcharge, and other negative (but difficult to quantify) impacts within and without the zone. Impacts of the 1981 program are summarized in Table A2.2.

Certain features of the program were adjusted during the summer of 1982 in order to ensure financial self-sufficiency. The daily permit price was dropped to $3.00; the shuttle service was eliminated; the zone was contracted to less than one square mile; and free permits to residents were controlled more carefully.

In contrast to the 1981 program, which operated seven days a week, the 1982 program operated only on weekends and holidays. As a result of these changes, the magnitude of the 1981 impacts decreased substantially. On the other hand, the costs also dropped. The program expenditures during 1982 were $46,000--including $20,000 for the full-time one-year salary of the coordinator and $12,000 for demonstration data collection. The revenues from permit sales and citations amounted to $29,500. Thus, while nominally the 1982 program was in the red, it would have been more than self-supporting if the data collection had been unnecessary, and the coordinator had been hired only for six months.

/8/ The annual cost of the shuttle service is estimated to be $60,000.

/9/ One might have expected to see a decrease in the violators as the program proceeded. This was not observed, however, over the first 20 days. In any case, permit sales are likely to rise as violations decrease, partly affecting revenue losses due to fewer citations.

TABLE A2.2: SUMMARY OF IMPACTS OF THE SANTA CRUZ PROGRAM IN 1981

BENEFITS	
1) Zone residents	Large gain in benefits due to dramatic reduction in non-resident vehicle parking (500 to 200)
2) Former non-resident parkers	Aggregate loss in benefits of $1,750/day
a. continue to park	Loss in benefits due to parking charge or violation fines
b. use shuttle bus	Loss for most--forced out of preferred mode (gain for few who were attracted to new bus service)
c. go elsewhere _or_ forego trip	Loss due to shift away from preferred destination
3) Merchants in the zone	Loss _if_ actual decline in sales recorded
4) Other zones	Possible adverse impacts on parking and traffic-related problems due to spillover

COSTS		
1) Capital Expenditures		$ 875/day
2) Continuing Costs		$ 1,915/day
3) Revenues		
a. daily permits	$ 500/day	
b. citations	1,250/day	
c. guest permits	50/day	
Total		-$1,800/day
4) Net Cost		$ 990/day

Alternatives

Alternative strategies for discouraging beach traffic involve restrictions which have proven unacceptable for a variety of reasons. A complete parking ban in the zone would deny access completely. A selective parking ban along some of the streets was actually tried, but rejected by the residents who lived along streets where parking was allowed. Also rejected by the residents and the County was a proposal to install parking meters. Meters in the residential area were perceived to be unsafe, unsightly, and very costly to install and maintain (particularly since they would be needed only over the summer season).

Alterations to the program implemented during the summer of 1982 promised a much more viable outcome. Lower prices for daily permits probably has attracted more parkers. The decrease in zone size has lowered revenues, but the enforcement costs have also been reduced. In addition, the elimination of shuttle service has produced significant cost savings. The program in 1983 appears on its way to being self-sufficient.

Reference

Rhyner, G. and Webb, P. (1983). "Parking Permit Demonstration Project in Santa Cruz, Ca." Draft Report prepared by Crain & Associates for Transportation Systems Center.

Case Study A3: Santa Monica Freeway Diamond Lane Program

The Santa Monica Freeway (Interstate I-10) runs for approximately 13 miles from the ocean in Santa Monica to the Harbor Freeway at the outskirts of downtown Los Angeles. Mostly eight lanes with a 22-foot median, it is one of the most heavily traveled freeways in the world. In the spring of 1975, 240,000 vehicles per day traveled on the east portion near the Harbor Freeway, and 100,000 vehicles a day traveled on the western end in Santa Monica. Many advanced traffic control devices operate on this freeway, including ramp metering for preferential entry of vehicles carrying two or more passengers; a computerized surveillance system; and centrally controlled electronic displays giving information about road conditions, expected delays, and recommended speeds.

The Santa Monica Diamond Lane project was the first time that existing lanes of a busy freeway had been dedicated for the exclusive use of high-occupancy vehicles. The project was sponsored by CALTRANS along with bus operators and the state police. The Service and Management Demonstration Program of UMTA sponsored a detailed evaluation/1/.

The principal goals were to improve air quality, reduce energy consumption, reduce congestion, and generally increase efficiency of the freeway in peak periods. The intent was to expand the effective capacity of the corridor by increasing the occupancy of vehicles. This could be achieved, it was believed, if the speed and reliability of transit and carpool travel were improved.

During peak periods (6:30-9:30 a.m. and 3:00-7:00 p.m.) the median lane in each direction on the Freeway between Lincoln Boulevard in Santa Monica and Harbor Freeway in downtown Los Angeles, a distance of 12.6 miles, was dedicated to the exclusive use of buses and carpools and vanpools with three or more persons. The exclusive lanes were marked by road signs and by diamonds painted on the pavement. However, no physical barrier separated them from the general traffic lanes. The California Highway Patrol enforced proper usage, and used the median for citing violators. At the beginning of the program, the enforcement level was doubled from the prior level of 76 manhours per day, but after the first month the manpower was reduced to its pre-program level as automobile drivers became familiar with the program and violations declined.

Several other measures were also introduced as part of the program. Three park-and-ride lots (with a total of over 500 spaces) served by express bus service were set aside in western Los Angeles. A variety of other express bus service was also introduced in the study area. Total routes more than doubled, and total bus departures increased by a factor of four to five.

After two years of planning, the program began on March 15, 1976. On the opening day, tremendous confusion developed. Severe congestion lasted through the day on entrance ramps and on the highway. Many accidents were reported. In fact, even though things settled down to normal within the next day or so, the first day feelings of outrage and the derisive reaction by the media were

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/1/ See Billheimer et al. (1977), and Public Technology, Inc. (1977).

never fully forgotten.

Set up as a one-year demonstration, the program would have been continued if the impacts had been favorable. However, after only 21 weeks of operation, it ended under a court order. Tremendous opposition from automobile drives, elected officials, and the media led to successful litigation on the grounds that the State Environmental Impact Report had not been filed properly. The public outcry was so great that the state DOT decided not to pursue the additional environmental studies required by the court order. Instead, the program ended.

The impacts discussed in this case study describe the conditions over the last few weeks of the program when it was running relatively smoothly. Because the program was so short-lived, it is very likely that it did not stabilize fully.

Benefits

The principal impacts were changes in travel patterns and their ramification for congestion, pollution, and VMT. Table A3.1 summarizes the impact on the flow of vehicles and persons over the major routes within the corridor. It is necessary to look at flows on both the freeway and the parallel facilities in order to provide a comprehensive picture of the overall impacts.

Vehicle occupancies increased in the peak periods as the freeway carried about two percent fewer people in ten percent fewer vehicles. Over the surface streets, one percent more persons traveled in five percent fewer cars. Overall vehicle occupancy went up from 1.24 to 1.35. Carpools increased by over 60 percent, and bus ridership more than tripled.

Speeds also changed over the corridor facilities. Table A3.2 summarizes the effects on speeds and on travel times. Speeds in the diamond lanes were from two to five mph higher than before the program, and were also more stable. This made travel over the entire length two to three minutes faster than before. At the same time, speed and stability declined for the other freeway lanes and on parallel surface streets. The near 20 percent decline in speeds over other lanes of the freeway during the morning implied a four-minute increase in travel time. In the evening peak, the before speeds were already much lower than morning rush hours, and the decline due to the diamond lanes was only slight. The evening trip times increased by only about one minute on the average. Adding the ramp delays, the freeway trip time in the morning on other lanes increased by six to seven minutes due to the lane dedication. An important result of the increased congestion on other lanes and parallel streets, and of the speed differential (10 mph) between diamond and other freeway lanes, was an alarming increase in accidents. Accident rates during the diamond lane operating hours went up by a factor of 2.5.

The impacts presented in this case study reflect the expansion of the bus service as well as the dedication of the diamond lane. Available data do not allow separation of the impacts of each measure. It is believed, however, that the expansion in bus service by itself probably would have had only a minor impact on flows in absolute terms, since the principal shifts due to the program were in carpool use. Carpool usage increased by about 7,000 person trips compared with an increase of about 2,500 in bus ridership. The latter

Table A3.1: IMPACTS ON PEAK-PERIOD VEHICLE FLOWS AND PERSON TRIPS

	Before		During	
	Number	Percent	Number	Percent
	(thousands)		(thousands)	
ON THE FREEWAY (at Crenshaw Boulevard)				
Vehicles:				
Cars#	108.0	96%	95.0	94%
Car- and Vanpools	3.6	3	5.8	6
Buses	0.1	-	0.3	-
Total	111.7	100	101.1	100
Persons in:				
Cars#	125.0	90%	112.0	83%
Car- and Vanpools	13.0	9	20.0	15
Buses	1.2	1	3.7	3
Total	139.2	100	135.7	100
ON PARALLEL SURFACE STREETS (total of 7 streets)				
Vehicles:				
AM Peak	19.0		17.0	
PM Peak	25.0		25.0	
Persons:				
AM Peak	23.0		21.5	
PM Peak	34.0		36.0	

Notes: Data for the seven hours per day of diamond lane operation.

\# "Cars" refers to vehicles with fewer than three persons.

Source: Derived from Billheimer, et al. (1977).

apparently was due largely to bus service expansion rather than the dedication of the diamond lane; the bus ridership loss at the end of the diamond lane experiment was only about 500 trips.

The program failed to generate the large anticipated benefits in fuel consumption and air quality. Fuel consumption in the corridor declined by less than one percent, while no appreciable change in vehicle emissions could be measured.

Table A3.2: SPEED AND TRAVEL TIME IMPACTS

	BEFORE		DURING	
	Speed	Travel Time#	Speed	Travel Time#
	(mph)	(minutes)	(mph)	(minutes)
ON THE FREEWAY				
Diamond Lane				
A.M. Peak	51.0	16.0	53.0	15.0
P.M. Peak	44.0	18.5	49.0	16.0
Other Lanes				
A.M. Peak	51.0	16.0	41.0	20.0
P.M. Peak	43.5	18.5	42.0	19.5
Metered Entrance Ramps				
A.M. Peak	-	-	-	1-2 minute increase
P.M. Peak	-	-	-	5 minute increase
ON PARALLEL SURFACE STREETS				
A.M.	27.0	27.0	26.0	28.0
P.M.	24.0	30.0	23.0	31.0

Note: # time to travel 12.5 miles of the Diamond Lane

Source: Derived from Billheimer et al. (1977).

The principal changes in user benefits were brought about by speed changes. Obviously, such changes (summarized in Table A3.2) also result in altered operating costs of all vehicles, although these changes were probably quite small since the speed changes were minor in absolute magnitude. Consequently, the focus of benefit assessment of such programs should be on time

changes/2/. In addition to the user benefits, the assessment also must estimate other major impacts. In this case study, we have identified the two major impacts--fuel consumption and air quality--which were the principal reasons for implementing the program. The changes in benefits brought about by the program are summarized in Table A3.3.

Table A3.3: CHANGES IN BENEFITS

USER BENEFITS	
1) On The Freeway	
a. Automobile Users in other lanes	Large loss in benefits (112,000 persons lost an average of 3 to 4 minutes--a 20 percent loss in time).
b. Carpool Users in the diamond lane	Gain in benefits (20,000 persons gained an average of 1 to 2 minutes--a 5 percent increase).
c. Bus Riders in the diamond lane	Gain in benefits (3,700 persons gained 1 to 2 minutes on freeway, plus as much as 10 to 15 minutes of lower waiting and access time due to expanded routes and schedules).
2) Parallel Surface Streets	Loss in benefits (57,000 persons lost about one minute each).
3) Accidents	Increased from an average of 10 to 25 per day
OTHER IMPACTS	
1) Fuel Consumption	Declined 0.8 percent
2) Vehicle Emissions	No significant change

Note: Fuel consumption and emission impacts were on the bases of VMT changes.

Source: Derived from Billheimer et al. (1977)

/2/ Obviously, due to the changes in access and egress conditions, the actual door-to-door trip time changes would be different from the trip time changes on the line-haul facilities. However, since we cannot identify these clearly, we focus exclusively on the line-haul portion.

Clearly, overwhelmingly large fractions of the corridor users lost benefits. Out of about 193,000 persons using the freeway and parallel streets, as many as 169,000 suffered lower speeds. At most only 24,000 carpool and bus riders gained benefits. The actual number of gainers probably is smaller than 24,000 because at least some of the carpoolers and bus riders were pushed out of their preferred mode--the automobile--because of the longer trip times in auto (rather than being attracted by the faster carpools and faster, frequent, and more accessible bus service). As a result of these impacts, in aggregate the users appear to have lost a substantial amount. Accident costs also increased significantly. Against these losses the program failed to generate any significant benefits. The anticipated fuel savings and decline in vehicle emissions failed to materialize.

Costs and Cost-Effectiveness

Total funding for this project has been estimated at $3,126,000 (in 1976 dollars). The breakdown of costs by categories is shown in Table A3.4. The capital expenditures for diamond lanes were only $163,000--for signs and painting. Diamond lane operating costs were $623,000 for the period. The two largest cost categories were bus operations ($1,100,000) and the evaluation effort ($1,237,000). A city contemplating only a diamond lane program could avoid most of the costs incurred for the last two items above. The yearly operating costs also would be substantially lower after the first year, since its principal component ($358,000 in marketing and information dissemination) can be reduced substantially. In fact, overall operating costs could probably be reduced by more than 50 percent in another site.

Obviously, the principal aim was not simply to increase user benefits. The ultimate goal was to bring about increased usage and productivity for high-occupancy vehicles, and thereby achieve energy savings, reduce vehicle emissions, and improve overall accessibility in the corridor. While the program did succeed in attracting automobile riders to carpools and buses, and

Table A3.4: SUMMARY OF PROGRAM COSTS

Cost Elements		
Signs and Painting		$ 163,000
Marketing/Information Disseminaton		358,000
Local Agency Administration		193,000
Court Costs		58,000
Compliance with Court Orders		20,000
Bus Operations		1,100,000
Evaluation & Data Collection		1,237,000
	TOTAL	$3,126,000

Source: Derived from Billheimer et al., (1977).

while overall vehicle occupancy and freeway capacity were increased at minimum construction and enforcement costs, the overall impacts were not positive. Automobile users lost much more than carpoolers and bus riders gained. Accidents increased. And most importantly, the program failed to reduce energy consumption or vehicle emissions.

The gainers and potential supporters of the program were completely outnumbered by the losers and critics. More than 80 percent of freeway users and almost all of the users of parallel streets were losers. Twenty percent of the users claimed that they were forced to make significant changes in travel patterns. In fact, 86 percent of the freeway users surveyed (including carpoolers) claimed that the diamond lanes were harmful or provided no benefits. On top of these adversities, the media were very critical of the program.

Alternatives

Several alternatives might have been more effective in meeting the local goals. Instead of allowing only carpools with three or more persons to use the diamond lanes, planners could have included any vehicle with more than one person. This would have encouraged greater use of the exclusive lanes, and reduced congestion in the other lanes. The diamond lanes operated with considerable spare capacity, and could probably have accommodated most of the two-occupant cars without a significant drop in service levels. Original plans did consider this option, but opponents predicted that heavy use of the diamond lanes would have resulted.

Possibly the most effective alternative would have been to price the entire freeway. This strategy would have reduced congestion significantly, effected greater shifts to high-occupancy vehicles, reduced fuel consumption, improved air quality, and generated revenues. Needless to say, any pricing alternatives would face strong political opposition. Nevertheless, short of building extra capacity, the pricing solution is probably the only effective alternative for the conditions prevalent on the Santa Monica Freeway.

References

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Public Technology Inc. (1977). "Manual on Planning and Implementing Priority Techniques for High Occupancy Vehicles: Technical Guide." Washington, DC: Public Technology, Inc.

ESTIMATING CHANGES IN VEHICLE MILES OF TRAVEL (VMT)

This appendix presents the methodology and assumptions used to estimate the reductions in vehicle miles of travel (VMT) for several illustrative case studies.

HOME-TO-WORK TRAVEL

The Aerospace/SAMSO program (Case Study H1) appears to have achieved quite significant VMT reductions, although they can be estimated only approximately from available data. If the entire modal shift observed between September 1973 and 1978 is attributed to the program, and if this impact is applied to the 1978 employment level of 6600, the daily VMT reduction with respect to commuter travel in 1978 can be estimated as shown in table A.1. This is likely to be an overestimate, however, because many of the carpools which are known to have formed during the gasoline shortage but before the program began would probably have continued even without the program.

TABLE A.1

DAILY VMT REDUCTIONS FOR AEROSPACE/SAMSO COMMUTER TRAVEL (1978)

Mode	Net Number of Commuters Shifted Daily	Average Vehicle Occupancy	Average Daily Vehicle Round Trip[1] (Miles)	Daily VMT Reduction
Drive alone	-1188	1.0	28	-33,264
Car Pool	990	2.5	28	11,088
Van Pool[2]	198	10.0	60	1,663
			TOTAL	-20,513

[1]Estimates - Data unavailable

[2]A van is considered equivalent to 1.4 automobiles for VMT purposes.

Since the shifting of drive alone commuters to car or vanpools makes more automobiles available to other household members, programs like Aerospace/SAMSO undoubtedly generate some additional automobile travel that partly offsets the commuter VMT reduction. Information available from surveys of carpoolers and vanpoolers can be used to estimate this additional automobile VMT.[1] In these surveys, from 12 to 15 percent of the carpoolers and vanpoolers reported additional automobile use by other household members of from 1 to 12 miles per day. If we assume that 15 percent of the households of Aerospace/SAMSO carpool and vanpool users travel an extra 4 miles per day, the daily commuter VMT savings shown in table A.1 would be offset by 715, about 4 percent.

Program elements such as the Aerospace/SAMSO vanpool services which provide convenient commuter travel from certain residential locations can influence people to locate their residences in the areas served and, over time, can have a significant impact on urban form and automobile use.[2] In a survey of commuter bus users living in the new town of Reston (Virginia), about 40 percent of the respondents indicated that they would not have chosen to reside in Reston (which is about 22 miles from Washington) had the bus service not been available.[3] This survey was taken about 5 years after the service began. It is reasonable to assume that during the first year of a commuter program there is no impact on residential choice because residents of an area cannot be sure that the program will be permanent. As each year goes by, however, it is more likely that some of the old residents as well as some of the new ones will be influenced to reside in the area by the program.

When the Aerospace/SAMSO VMT reductions shown in table A.1 are used to estimate the impact of the program over a period of time, adjustments should be made to reflect the influence of the vanpool element of the program on residential location decisions. In order to make such adjustments, however, we need more information about the mode shifts effected by the program: we need to know where the vanpool commuters would have lived in the absence of the program, how many would have traveled by single occupant automobiles, and how many would have joined carpools. Since the information available for the Aerospace/SAMSO program does not permit even rough estimates of these factors, we have made no attempt to quantify the effect of residential location decisions on the VMT impacts of the program. (It is clear from table A.1, of course, that this effect will be relatively small: the vanpools account for less than 15 percent of the commuters affected by the program.)

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1. See Peat, Marwick, and Mitchell (1976); Valk (1979); and Staten (1979).
2. See Edwards and Schofer (1976).
3. Furniss (1977), pp. 5-12.

Table A.2 uses the data in table A.1 to estimate net annual VMT impacts over a five-year program period. The table assumes an initial six month period of linear growth from zero at the outset to the final stable levels shown in table A.1. An adjustment for additional household travel is included based on the daily estimate presented above. The impacts shown in the table are intended to reflect five-year expectations for another company or public agency instituting a program like Aerospace/SAMSO. For the second through the fifth years, net VMT reductions are discounted to present values using a 10 percent discount rate.

TABLE A.2

NET ANNUAL VMT REDUCTIONS FOR AEROSPACE/SAMSO OVER A FIVE-YEAR PROGRAM PERIOD (MILLIONS OF MILES)

Year	Reductions for Commuter Travel	Additional Household Travel	Net Annual VMT Reduction	Present Value
1	3.85	- .14	3.71	3.71
2	5.13	- .18	4.95	4.50
3	5.13	- .18	4.95	4.09
4	5.13	- .18	4.95	3.72
5	5.13	- .18	4.95	3.38
			TOTAL	19.40
			Average Per Year	3.88

Assumes 250 work days per year

The TVA program (Case Study H8) also has had a substantial impact on VMT. If the entire shift observed between November 1973 and January 1977 is attributed to the program, and if this impact is applied to the 1977 employment level of 3400, the daily VMT reduction with respect to commuter travel can be estimated as 29,906 as shown in table A.3. (This is likely to be an over-estimate for the same reason as the Aerospace/ SAMSO VMT reduction calculated in table A.1.) If we assume as for Aerospace/SAMSO that 15 percent of the households of TVA carpool

vanpool, and express bus users travel an extra 4 miles per day, the daily commuter VMT savings shown in table A.3 would be offset by 980, about 3 percent.

TABLE A.3

DAILY VMT REDUCTIONS FOR TVA COMMUTER TRAVEL (JANUARY 1977)

Mode	Net Number of Commuters Shifted Daily	Average Vehicle Occupancy	Average Daily Vehicle Round Trip (Miles)	Daily VMT Reduction
Drive alone	-1598[2]	1.0	22	-35,156
Carpool	374	3.2	22	2,571
Express Bus[1]	952	41.4	22	1,518
Vanpool[1]	238	13.2	46	1,161
			TOTAL	-29,906

[1]A bus is considered equivalent to three automobiles and a van equivalent to 1.4 automobiles for VMT purposes.

[2]Includes commuters shifted to modes not accounted for here (e.g., bicycle).

Source: Wegmann, et al (1978).

As for the Aerospace/SAMSO program, certain elements of the TVA program have probably had an impact on residential location decisions over time. In particular, the vanpool and express bus modes have provided convenient commuter travel from the locations they serve and probably have been important factors in the decisions of certain households to locate in those areas. Information available on the TVA program is no more helpful than that for Aerospace/SAMSO, however, in suggesting the impact the program may have had on residential location. Unlike the Aerospace/SAMSO program, the TVA impact could have been substantial: the express bus and vanpool modes account for almost 75 percent of the commuters affected by the program. But in the absence of even fragmentary information on this impact, we have made no attempt to quantify its effect on the VMT reductions achieved by the program.

For a company or public agency considering a program like TVA's, the expected VMT impact over a five-year program period is calculated in table A.4 using the same procedures as for Aerospace/SAMSO. We assumed that the commuter VMT reductions grow linearly during the first six months from zero to the final stable levels shown in table A.3 and then stay at those levels for the remainder of the five-year period. The impact of additional household travel is included based on the daily estimate developed above. For the second through the fifth years the net VMT reductions are discounted to present values using a 10 percent discount rate.

TABLE A.4

NET ANNUAL VMT REDUCTIONS FOR TVA OVER A FIVE-YEAR PROGRAM PERIOD (MILLIONS OF MILES)

Year	Reductions for Commuter Travel	Additional Household Travel	Net Annual VMT Reduction	Present Value
1	5.61	- .18	5.43	5.43
2	7.48	- .24	7.24	6.58
3	7.48	- .24	7.24	5.98
4	7.48	- .24	7.24	5.12
5	7.48	- .24	7.24	4.94
			TOTAL	28.05
			Average Per Year	5.61

Assumes 250 work days per year

The vanpool program administered by the <u>Golden Gate Bridge, Highway, and Transportation District (GGBHTD)</u> (Case Study H4) is projected to have an increasing impact on VMT over a five year period. Table B.5 shows the daily impact predicted by GGBHTD for fiscal year 78/79. Over the five years through fiscal 82/83 GGBHTD staff predict that the number of commuters shifted daily will increase from 440 to 640, 790, 940, and 1090 respectively. The staff have assumed that all of the increased van use will be at the expense of single occupant automobiles and carpools, which taken together would have averaged 1.36 persons per automobile. This may be optimistic considering that during the first

eight months of the demonstration about 65 percent of the van users were former transit riders, and only 15 percent were former single occupant automobile users. However, since the bus system is operating at close to capacity with no expansion planned, it is plausible that there will be a continuing demand by automobile users for the bus seats vacated by van users.

The GGBHTD program undoubtedly generates some increased household usage of the automobiles left at home by former automobile users. Assuming as for Aerospace/SAMSO and TVA that 15 percent of these households travel an extra 4 miles per day, the daily commuter VMT savings shown in table A.5 should be offset by 260, about one percent.

TABLE A.5

DAILY VMT REDUCTIONS FOR COMMUTER TRAVEL FROM GGBHTD VAN POOL PROGRAM (FISCAL YEAR 78/79)

Mode Shift	Number of Commuters Shifted Daily	Average Vehicle Occupancy	Average Daily Vehicle Round Trip (Miles)	Daily VMT Reduction
Automobile to Van[1]	440	1.36 to 10	75 to 80	19,340

[1]A van is considered equivalent to 1.4 automobiles for VMT purposes.

Source: Golden Gate Bridge, Highway, and Transportation District (1979).

As for Aerospace/SAMSO and TVA, the influence of the GGBHTD program on the residential location of van pool users is impossible to estimate from the information currently available. And if it is true (as indicated to date) that many van users would otherwise be transit riders, and that much of the VMT reduction results from <u>other</u> automobile users taking transit seats vacated by van users, the impact of changes in residential location on VMT reductions is complex indeed. While the net effect is probably some offset to the VMT reduction achieved by the program over time, it is impossible to quantify that offset in even approximate terms from existing information.

Table A.6 expresses the VMT impact of the GGBHTD program over a five year period. The year by year VMT reductions are based on the

GGBHTD projections for van usage listed above. The additional household travel stimulated by the program is assumed to grow in proportion to van usage over the period. Projected VMT reductions for the second through the fifth years are discounted to present values using a 10 percent discount rate.

TABLE A.6

NET ANNUAL VMT REDUCTIONS FOR GGBHTD VAN POOL PROGRAM OVER A FIVE-YEAR PROGRAM PERIOD (MILLIONS OF MILES)

Year	Reductions for Commuter Travel	Additional Household Travel	Net Annual VMT Reduction	Present Value
1	4.85	.05	4.79	4.79
2	7.03	.07	6.96	6.33
3	8.68	.09	8.59	7.10
4	10.33	.11	10.22	7.68
5	11.98	.12	11.86	8.10
			TOTAL	34.0
			Average Per Year	6.8

Assumes 250 work days per year

GENERAL PURPOSE TRAVEL

For the Westport program, the travel impacts reported in Case Study G2 provide the initial data needed for examining the probable effects of the WTD services on VMT. If all of the WTD services were terminated, tables G2.1 and G2.3 suggest that an extra 10,820 auto driver trips, an extra 15,250 auto passenger trips, and an extra 3,590 taxi trips would be taken in Westport per month. In order to estimate the VMT effects of the WTD services, we assume that:

- For auto driver trips, vehicle miles generated equal passenger miles; and for auto passenger and taxi trips, vehicle miles generated equal twice the passenger miles (this assumes that the driver is traveling only to deliver the passenger)

- WTD vehicles are equivalent to 1.4 automobiles for VMT purposes
- The Minnybus serves 42,000 WTD trips per month at a rate of 20 trips per vehicle hour and the Maxytaxy serves 13,000 at 4.5 trips per vehicle hour, both operating at average vehicle speeds of 15 m.p.h.
- Person trip lengths average two miles

Then the VMT reduction per month is given by

$$(10{,}820 \times 2) + (18{,}840 \times 2 \times 2)$$

$$- \frac{42{,}000}{20} + \frac{13{,}000}{4.5} \quad \times 15 \times 1.4 = -\,7{,}800$$

The WTD services thus appear to effect a small net <u>increase</u> in VMT in Westport.

The VMT effects of the <u>Danville Runaround</u> can also be estimated roughly from the travel impacts reported in Case Study G1. Tables G1.1 and G1.3 suggest that if the Runaround services were terminated, an extra 5280 auto driver trips, an extra 2640 auto passenger trips, and an extra 6600 shared taxi trips would be taken in Danville each month. Assuming as for Westport that for auto driver trips vehicle miles equal passenger miles and for auto passenger and shared taxi trips vehicle miles equal twice the passenger miles; assuming that Runaround buses are equivalent to three automobiles for VMT purposes; assuming that Runaround buses serve 22,000 trips per month at a rate of 13 per hour and at a speed of 12 m.p.h.; and assuming an average person trip length of two miles, the VMT reduction per month is given by

$$(5{,}280 \times 2) + (9{,}240 \times 2 \times 2)$$

$$- \frac{22{,}000}{13} \quad 12 \times 3.0 \quad = -13{,}400$$

As for Westport, therefore, the Danville system appears to increase overall VMT slightly.

In both of these examples the estimation of VMT impacts required certain assumptions to fill data gaps. Though the assumptions are based on other supporting data from the systems, the VMT estimates must be regarded as somewhat uncertain. The results are sufficiently sensitive to the assumptions made that changes in certain quantities could turn the small VMT increases into small VMT decreases. Perhaps the best tentative conclusion from these results is that the systems have little or no impact on VMT in their respective cities.

The Mercer County (Case Study G5) off-peak fare free transit program attracted automobile users to transit without any increases in bus miles operated. Table G5.3 suggests that in the absence of the program an additional 3780 auto driver and 2940 auto passenger trips would have been made per week. If we assume that for auto driver trips, vehicle miles equal passenger miles, and for auto passenger trips vehicle miles equal twice the passenger miles, the average trip length of three miles results in a weekly VMT savings of about 29,000 and an annual VMT savings of about 1.5 million.

For the Atlanta Program (Case Study G6) estimates of the VMT impacts of the first twelve months were made as follows. During this period, the volume of bus miles operated increased by almost 2 million (or 10.5%) over the preceding twelve month period. Counting a bus mile as equivalent to 3.0 private car miles, this extra supply averaged 115,000 automobile mile equivalents per week.

Table A.7 uses data from the November 1972 on-board survey of riders (as well as from other sources) in an attempt to estimate the weekly volume of private car miles foregone, because of modal shifts, over the first year following the fare cut. The survey report produced estimates of the volumes of unlinked bus trips generated as result of the program, classified by the time period within which the trips were made (line A). We have worked with the data disaggregated by time of day because such data are available, but in the absence of this type of information weekly averages could be used instead. Overall, the proportion of the trips which were transfer rides was calculated from the operating statistics averaged over the year following the fare cut, and this overall average was modulated for each of the time periods on the basis of the survey evidence. The resultant estimates of generated originating trips (line C) exceeded the volume derived for November 1972 from the time series model analysis by about 36%, and exceeded the model's volume averaged over the full twelve month period (165.6 thousand trips per week) by 46%. In order to base the analysis consistently on the model-generated estimates, the figures for each time period were scaled accordingly (line D).

Next, on-board survey data describing the claimed previous travel behavior of "new riders" (line E) were used to estimate the volumes of private car trips foregone in each time period (line F). It was assumed that, on average, a former trip made as a car passenger was equivalent (in automobile miles) to 0.75 of a former "automobile driver" trip. If all former car passenger trips were serviced by someone else delivering the passenger and then returning, the appropriate ratio would be 2.0. At the other extreme, if all of the former passenger trips were made with minimal adjustments to the car drivers' travel patterns, the appropriate ratio would be close to zero. An assumed value of 0.75 seems reasonable under the Atlanta circumstances. Former taxicab trips were assumed to be equivalent in vehicle mileage to 1.25 car driver trips.

TABLE A.7

ESTIMATE OF VMT SAVINGS FROM MODAL SHIFTS, ATLANTA PROGRAM

Data are for an "average week"	weekday				Saturday	Sunday	total
	AM peak	midday	PM peak	evening			
A. New unlinked trips, thousands (1)	48.7	72.6	102.0	35.7	33.4	19.0	311.3
B. % originating trips (2)	76.8	77.8	77.5	80.4	79.2	72.9	77.7
C. Unadjusted new linked trips, thousands	37.4	56.5	79.1	28.7	26.5	13.8	241.9
D. Adjusted new linked trips, thousands	25.6	38.7	54.1	19.7	18.1	9.5	165.6
E. % diverted (3) from							
automobile driver	51.3	38.5	36.8	49.9	33.2	29.7	41.0
automobile passenger	18.6	22.5	21.9	24.9	18.8	21.3	21.7
taxicab	1.2	8.8	4.7	4.9	5.6	3.5	5.2
F. Equivalent car trips foregone, thousands	17.1	25.7	32.0	14.7	9.8	4.7	104.0
G. Assumed mean trip length, miles	10.6	9.5	9.7	9.5	9.1	10.0	9.7
H. Gross car miles foregone, thousands	181.2	243.8	310.3	139.5	89.6	47.3	1011.6
J. % trips accessed (4) as							
automobile driver	10.6	4.8	1.4	0.0	0.0	0.0	3.2
automobile passesnger	12.5	5.6	4.5	2.7	2.7	2.7	5.5
K. Ratio of car access/egress trips to new bus trips	0.350	0.224	0.286	0.069	0.069	0.069	0.219
L. Equivalent car access trips, thousands	9.0	8.7	15.5	1.3	1.2	0.6	36.3
M. Car miles for access trips, thousands	17.9	17.3	30.9	2.7	2.5	1.3	72.6
N. Net change in car miles, thousands	163.3	226.5	279.4	136.8	87.1	46.0	939.0

Slight internal descrepancies in the table are due to a final rounding of figures cited here.

Notes: (1) From MARTA (1975), table 8.
(2) Relative ratios by time period are derived from MARTA (1975), table 20.
(3) From MARTA (1974), table 27, corrected for inconsistencies.
(4) From MARTA (1974), table 24.

Applying these weighted diversion percentages to the volumes of new linked trips on the bus system suggests that a total of around 104,000 car trips were foregone each week as a result of people switching to the bus (line F). The average lengths of these trips have been assumed (line G), on the basis of fragmentary evidence from the on-board survey and more recent MARTA data. The implied volume of car miles foregone is consequently just over 1.0 million per week.

Offsetting this amount, however, is the additional automobile mileage of those people who used cars to travel to and from the bus system, as well as any additional use of the cars left at home. We have no data on the latter effect, but the on-board survey information provides some clues about the use of automobiles to access the bus (line J). In this case, an access trip as an automobile passenger was assumed to be equivalent in mileage to 1.5 trips as an automobile driver: the ratio will be relatively high because of the "kiss and ride" phenomenon. Overall, the survey showed that new bus trips involving <u>egress</u> from the bus to the final destination by car were about 30% less than those <u>accessed</u> by car. These fragmentary pieces of information and assumptions produce the estimates of equivalent car access trip volumes shown in line L. At an assumed average of 2.0 miles per access trip, the aggregate mileage of cars used in getting to and from the generated bus trips approximates 73 thousand per week.

In net, then, the reduction in vehicle miles as a result of the program, averaged over the twelve months following the fare cut, is estimated to be around 824 thousand VMT per week -- that is, 1011.6 thousand from diverted trips, less the 72.6 thousand from new access trips and the 115.2 thousand from extra bus service. This is equivalent to an annual reduction of 42.8 million miles, or around 5.0 miles per generated bus trip. As a frame of reference, this saving is about two-fifths of one percent of the estimated total VMT for the Atlanta metropolitan area in 1972.

If we assume that the level of VMT reduction continued steadily throughout a five-year program period, the average annual discounted saving was approximately 35.7 million miles.

These calculations are quite sensitive to the survey responses about travel behavior before the fare cut, which we have interpreted as suggesting that each 100 extra bus trips generated implied the reduction of almost 63 automobile trips. We suspect that this may be an over-estimate.

Appendix B

COMPUTING PROGRAM ASSESSMENT MEASURES

To illustrate how the program characteristics and performance measures for typical projects are computed, this appendix presents a step-by-step description of the calculations using information from the Aerospace/SAMSO commuter program (Case Study H1), the Seattle lift-equipped bus service (Case Study S4), the Danville Runaround System (Case Study G1), and the Atlanta bus fare reduction (Case Study G6).

HOME-TO-WORK PROGRAMS

The first step in assessing a home-to-work program is to estimate the number of annual one-way trips served for each year over a five-year assessment period. If daily ridership is used as a basis for estimating annual totals, then the same number of work days (we assume 250 days) per year should be used for all projects assessed.

For the Aerospace/SAMSO program (Case Study H1) the number of annual one-way trips served in the first year can be estimated based upon the number of commuters who shifted modes (see table H1.2). The computation is:

1188 commuters shifted x 2 trips per day x 250 days per year = 594,000 trips per year.

To make this ridership performance meaningful to other companies considering similar programs, we calculate the present value of the time stream of trips over five years, allowing for a gradual ridership growth from the program beginning. We assume that only half of the observed ridership will occur in the first year, and that the full level will occur in each of the next four years. Table B.1 shows the present value computations using a 10 percent discount rate.

To compute the program cost requires an estimate of start-up and on-going costs for each year over the assessment period. For the Aerospace/SAMSO case, the start-up costs in the first year would be about $25,800 in 1980 dollars, and the operating costs would be about $7,000 each year. The average of the present values over the five years reppresents the program cost per year (see table B.2).

The measure of VMT reduced is calculated as shown in Appendix A. For the Aerospace/SAMSO program the average discounted value per year over the five year period is 3.88 million miles.

TABLE B.1

COMPUTING THE TRIPS SERVED
MEASURE FOR AEROSPACE/SAMSO

Year	Estimated Annual One-Way Trips	Discount Factor	Present Value
1	297,000	1.0	297,000
2	594,000	.909	539,000
3	594,000	.826	490,600
4	594,000	.751	446,100
5	594,000	.683	405,700
		TOTAL	2,179,300
		Average per year	435,900

TABLE B.2

COMPUTING THE PROGRAM COST FOR
AEROSPACE/SAMSO

Year	Estimated Cost (1980 dollars)	Discount Factor	Present Value
1	\$32,800	1.00	\$32,800
2	7,000	.909	6,360
3	7,000	.826	5,780
4	7,000	.751	5,260
5	7,000	.683	4,780
		TOTAL	\$54,980
		Average per year	11,000

The user benefits resulting from the Aerospace/SAMSO program are estimated by halving the cost savings which would have resulted if all the program users had formerly driven to work alone in automobiles dedicated solely to that purpose. The rationale for this method is described in Appendix C. If the cost of owning (amortized) and operating an automobile, excluding parking, is 20.5 cents per mile in 1980, and the user costs for the van and carpoolers is 4 cents per user per mile, then the average discounted user benefits per year can be calculated based upon the estimated VMT reduction as:

$$\frac{(0.205 - 0.04) \times 3,880,000}{2} = \$320,100$$

This procedure is appropriate because according to table A.1 all the commuters attracted to high-occupancy modes by the Aerospace/SAMSO program formerly drove alone.

SPECIAL USER GROUP PROGRAMS

For the Seattle lift-equipped bus service (See Case Study S4) we assume that the first year one-way trips is 16,500 trips (see table S4.1) and that in the following years this figure doubles to 33,000. The present values using a 10 percent discount rate and the average over five years are computed as shown in table B.3.

TABLE B.3

COMPUTING THE TRIPS SERVED MEASURE FOR THE SEATTLE LIFT-EQUIPPED BUS SERVICE

Year	Estimated Annual One-Way Trips	Discount Factor	Present Value
1	16,500	1.0	16,500
2	33,000	.909	30,000
3	33,000	.826	27,300
4	33,000	.751	24,800
5	33,000	.683	22,500
		TOTAL	121,100
		Average per year	24,220

The annual program cost equals the annual total cost less the annual revenue. To compute the total cost we estimate the start-up, operating, and capital costs for the Seattle system for each year over a five year period. For a transit agency instituting the Seattle system the start-up costs (planning, marketing and training) would be about $80,000 in 1980 dollars. On-going annual costs would be $70,000 for maintenance and $45,000 for staff. The total capital costs for the lifts would be $6200 per unit. Straight line depreciation with no salvage value over 12 years results in a depreciation cost per lift per year of $517. These capital costs for 163 vehicles are combined with start-up and operating costs and discounted at a 10 percent rate over a five year period in table B.4. To determine average discounted annual revenue, the revenue per trip (15 cents) is multiplied by the average discounted trips served per year to give $3,633. Average discounted

program cost or subsidy per year is thus $182,100 less $3,633, or about $178,500.

TABLE B.4

COMPUTING THE TOTAL COST FOR THE SEATTLE LIFT BUS SERVICE

Year	Estimated Cost (1980 dollars)	Discount Factor	Present Value
1	279,200	1.00	279,200
2	199,200	.909	181,100
3	199,200	.826	164,500
4	199,200	.751	149,600
5	199,200	.683	136,000
		TOTAL	910,400
		Average per year	182,100

GENERAL PURPOSE PROGRAMS

For the Danville Runaround system we assume as in Case Study G1 that the first year one-way trips will be 17,000 per month or 204,000 per year, and that ridership in the next four years will be 288,000. The present values using a 10 percent discount rate and the average over the five year period are computed as shown in table B.5.

TABLE B.5

COMPUTING THE TRIPS SERVED MEASURE FOR THE DANVILLE SYSTEM

Year	Estimated Annual One-Way Trips	Discount Factor	Present Value
1	204,000	1.0	204,000
2	288,000	.909	261,800
3	288,000	.826	237,900
4	288,000	.751	216,300
5	288,000	.683	196,700
		TOTAL	1,116,700
		Average per year	233,300

The annual program cost equals the annual total cost less the annual revenue. For a city implementing the Danville system, the start-up costs would be about $55,100 in 1980 dollars. Annual costs would be $60,000 for administrative expenses, $9,000 for advertising, and $490,000 for operating (including vehicle depreciation). The present values and the average over five years are computed in table B.6. To determine the average discounted annual revenue, the revenue per trip (34 cents) is multiplied by the average discounted number of trips served per year. Average discounted program cost or subsidy per year is $477,100 less $75,922, or about $401,200.

TABLE B.6

COMPUTING THE TOTAL COST FOR THE DANVILLE SYSTEM

Year	Estimated Cost (1980 dollars)	Discount Factor	Present Value
1	614,100	1.00	614,100
2	559,000	.909	508,100
3	559,000	.826	461,700
4	559,000	.751	419,800
5	559,000	.683	381,800
		TOTAL	2,385,500
		Average per year	477,100

The procedure to estimate the ridership impacts for the Atlanta bus fare reduction is more complex than the one used for Danville's system. A time-series regression equation, derived from monthly operating data over a period spanning the fare change, is used to estimate the change in demand for originating trips and the change in user benefits. This analysis is presented in Appendix C, beginning on page C-6. The procedure used to estimate the ridership impacts of the Jacksonville case study also is found in Appendix C.

The costs of the first year of the Atlanta short-range improvement program were calculated as follows. For the fare reduction element, the main cost to the system itself was the sharp drop in revenues. The primary component of this is, in terms of Figure C.5 in Appendix C. The difference in area between the two rectangles OEML (the base fare revenues which would have been expected over the year following the fare cut had the reduction not been made) and OFJH, the revenues actually achieved over that year. This difference is given by

$$\text{revenues} = p_o q_o - p_1 q_1$$

$$= (171{,}053 \times 0.4) - (198{,}753 \times 0.15)$$

$38,608 per working day or $9.65 million over the year.

In 1980 dollars, this foregone revenue is roughly $18.92 million for the full year.

However, this is probably not the full extent of the revenue loss. As well as reducing the bus fare by 25 cents a ride, the fare cut abolished both the 5 cent transfer charge and zonal surcharges. To some extent, the behavioral response to those additional cuts may have been captured within the simple model, which uses the base fare rather than the average fare paid as the measure of price. However, it is probably safer to treat the foregone transfer charge and zonal surcharge revenues as additional losses. There are no data available which can provide estimates of the zonal surcharge amounts (and a relatively long average trip length on the system suggests they may have been of significant magnitude), but the foregone transfer charges can be estimated approximately. The ratio of transfer trips to originating trips increased only marginally (by less than 5%) following the fare change. If we apply the average ratio for the twelve months preceding the fare cut (0.274) to the projected post-change ridership without the reduction, the estimated loss in revenue from transfer charges is

$$\text{transfer revenues} = 171{,}053 \times 0.274 \times \$0.05$$

$2,340 per working day or $0.59 million for the year.

This increases the overall estimate of foregone revenues in the first year to $10.24 million in current dollars, or $20.07 million at 1980 prices, not including the zonal surcharge revenues foregone.

If the foregone revenues from the lowered fares are projected over a five-year program period for comparative purposes, the program costs in 1980 dollars over that period amount to $14.53 million per year.

There is little information from which to estimate the increased operating costs ascribable to the increase in bus miles provided over

the first year of MARTA operation. Simple regression analysis of the annual operating costs in the property's transportation account over the period from fiscal year 1973 through fiscal year 1977 (while the system's bus miles grew by almost 23%) suggests that the costs increased by an average of about 85.2 cents per additional bus mile in 1972/73 dollars, or $1.67 per mile in 1980 dollars. For the almost 2 million miles added over the year following the fare cut, therefore, the additional cost was probably about $1.70 million at current prices, or $3.34 million in 1980 dollars.

Offsetting these additional costs to the property were the <u>revenue increases</u> ascribable to the service enhancement, equivalent to the rectangle FGKJ in Figure C.5. These amount to just over $1,000 per working day, or $0.25 million for the full year. The net cost of the service expansion was thus $1.45 million over the first year, or $2.84 million in 1980 dollars. Over a five-year program period, the <u>program cost</u> would be $2.42 million at 1980 prices.

We have not estimated the amortized capital costs associated with the service expansion, largely because of data availability problems. A more careful appraisal would require consideration of the additional need for capital facilities (buses and garaging facilities, for instance) which can be ascribed to the service change, and the expense stream for these, properly deflated, discounted, and amortized, should be included in the costs. In the Atlanta situation over the year under consideration there was indeed some expansion in the bus fleet (mostly concentrated near the end of the year), but the associated costs and the extent to which the expansion could be ascribed to this year's service enhancements as distinct from future years' are not documented.

It is sometimes pointed out that money spent on service enhancements is different in economic terms from money devoted to supporting low fares. The former involves the allocation of real resources to transit whereas fare subsidies by themselves do not. Low fares represent not a "resource cost" but a "transfer payment": money is merely being transferred from the pockets of one group of people (the general taxpayers) to the pockets of another group (the passengers) without any extra resources being consumed. Therefore, it is argued, comparison of the two types of expenditure is not comparing like with like. But such a distinction may be a little trivial in practice. The benefits of reduced bus fares to the passenger arise because (and only insofar as) he can purchase other goods and services with the money he saves. Transfer payments indirectly lead to an equal consumption of real resources if the recipients spend the full amount on other things. Under most circumstances, however, some of the money will be saved, so that the immediate increase in spending will be less than the amount of the transfers. Moreover, the resources ultimately consumed with the funds will not necessarily be allocated to the transportation sector. Here, then, is the essence of the distinction: at full employment, government expenditures on service improvements will increase the consumption of real resources by the transportation sector (as distinct from the rest of the economy) to a greater extent than would the same

expenditures on fare reductions. Fare subsidies can also be expected to increase the immediate (but not ultimate) consumption of real resources by somewhat less than does an equal amount of direct public spending on expanded transit service. How much less will depend on how consumers adjust their budgets following the fare reduction. In the absence of detailed information about budgetary adjustments, any full-scale accounting of the costs and benefits to society of transit fare changes should probably include most or all of the transit operator's revenue change as a proxy for the consequent change in resources expended throughout the rest of the economy.

Some comment is also warranted about the choice of an appropriate program period over which to appraise transit fare and service changes. We have calculated benefits and costs on a five-year basis here primarily to make them comparable with other case studies in this volume. Typically, fares and service levels will not remain unchanged for five years, however, and if competing fare/service packages only are being evaluated a shorter time horizon would be quite adequate. Since the continuing benefits and costs from these types of policy are likely to be much greater than the non-recurring amounts, once the ridership response has been judged to have stabilized the stream of benefits and costs can be projected into the future (in constant dollar terms, and properly discounted) as far as the common time horizon adopted for judging between different options. The choice of a time horizon is not likely to be particularly important as long as it exceeds the time necessary for demand stabilization. Again, computation of the user benefits on a month by month basis, made possible by the estimation of a time series demand model, should reduce the need to be overly concerned about the conceptual problem of choosing an appropriate time horizon.

Appendix C

ESTIMATING USER BENEFITS

This appendix describes the methodology employed in developing estimates of user benefits for some of the projects presented in the main text.

HOME-TO-WORK TRAVEL

Programs like Aerospace/SAMSO (Case Study H1) and GGBHTD (Case Study H4) which effect travel mode shifts without withdrawing any existing travel opportunities clearly generate travel benefits for those who shift modes: these travelers decide to choose a new mode while the opportunity to use their old mode is still present. The value of these benefits can be calculated by estimating the change in consumer surplus effected by the program.

Suppose that the demand for high-occupancy packages like those offered by the Aerospace/SAMSO and GGBHTD programs is represented by the straight line demand schedule shown in figure C.1, with the amount actually consumed represented by q, the price paid by the users represented by p, and the price at which all the users would refuse to participate represented by p*. The increase in consumer surplus effected by the program is then the shaded area A, given by $(p^*-p)q/2$. The price p is the perceived user cost of participation, which we assume to be equal to the user's share of the full cost of operating the cars and vans involved in the program. We estimate p* by assuming that if the perceived user cost for the program were gradually increased, the most enthusiastic of the current users would finally abandon the program when the perceived user cost equalled the full cost of driving to work alone in an automobile used solely for that purpose. The increase in consumer surplus effected by the program is then given by one half of the cost savings which would have resulted if all the program users had formerly driven to work alone in automobiles dedicated solely to the purpose.

The TVA program (Case Study H8) differs from the Aerospace/SAMSO and GGBHTD programs in that the opportunity to drive has been reduced by the elimination of 1300 parking spaces at the TVA office location. In order to investigate the impact of the TVA program on consumer surplus, we consider the program in two hypothetical stages: a first stage in which the incentive part of the program is implemented alone, and then a second stage in which the number of parking spaces is

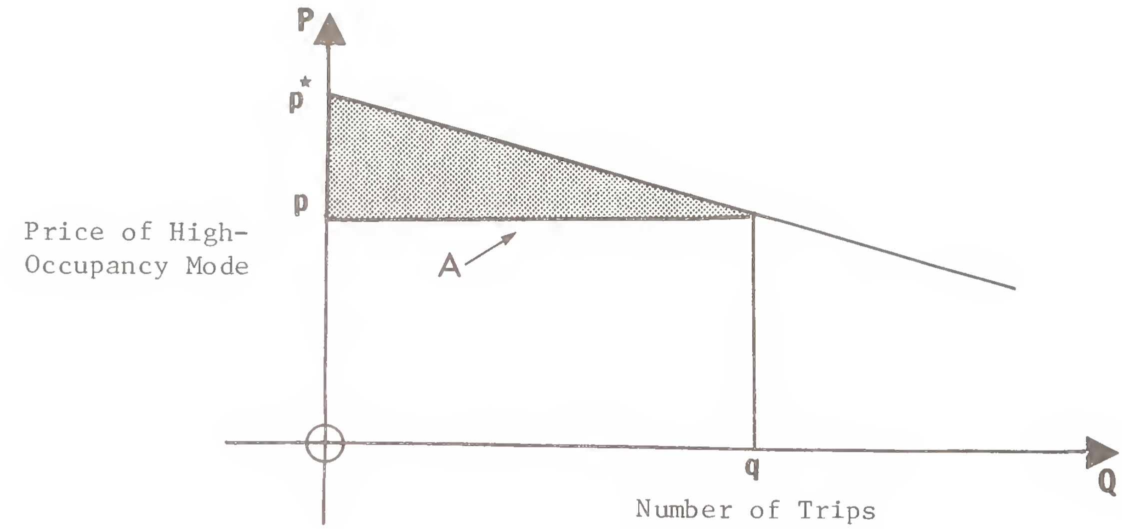

FIGURE C.1

DEMAND FOR HIGH-OCCUPANCY PACKAGE

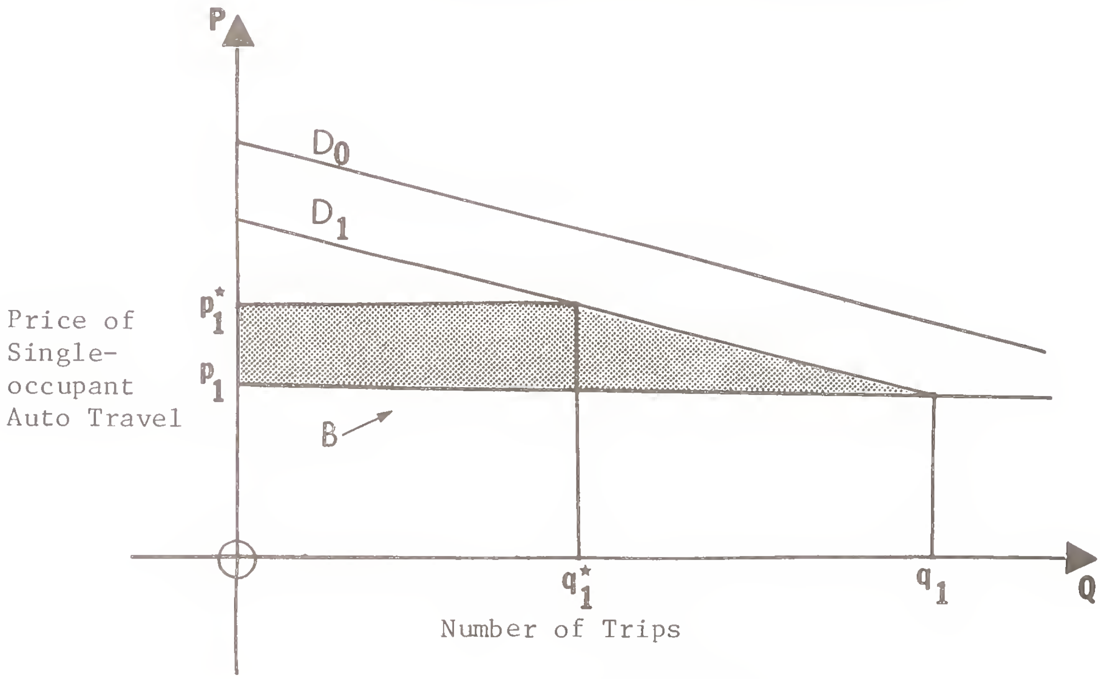

FIGURE C.2

DEMAND FOR SINGLE-OCCUPANT AUTOMOBILE

reduced.[1] The first stage of the program would be analogous to the Aerospace/SAMSO and GGBHTD programs, and can also be represented by figure C.1, with the change in consumer surplus again equal to the shaded area A, i.e., $(p^*-p)q/2$.

When the second stage of the TVA program is introduced, the reduction in the availability of parking results in an increase in the total price of driving alone. This increase will cause some additional auto drivers to switch to one of the high-occupancy modes, with a loss of consumer surplus relative to their situation under stage 1. Suppose that the demand for single-occupant auto travel in the absence of the first stage of the TVA program is represented by demand schedule D_0 in figure C.2, and that the first stage of the program results in a drop in this demand to D_1, with the price and quantity consumed during the first stage given by p_1 and q_1. Suppose that the second stage of the TVA program effectively raises the price of single-occupant auto travel to p_1^* with an accompanying drop in quantity to q_1^*. The loss of consumer surplus effected by stage 2 is then the shaded area B in figure C.2, given by $(p_1^*-p_1)(q_1^*+q_1)/2$.

The net effect on consumer surplus of the TVA program is then given by the difference between area A (the pluses) and area B (the minuses). Depending upon the values of the various price and quantity variables, this net effect could be positive, zero, or even negative. In the case of TVA, the parking spaces which were eliminated had a daily parking charge in 1974 of about \$1.00 per day (\$1.50 in 1980 dollars). Since parking was available close to TVA in 1980 at a daily charge of \$1.50, the actual effect on the price of single-occupant auto travel of eliminating the 1300 spaces in stage 2 appears to have been relatively small. Consequently, the effect on auto use was probably also quite small, and the area B in figure C.2 probably represents a relatively small offset to the stage 1 benefits represented by area A. (If the 1300 parking spaces had been free, however, the effect of eliminating them would have been substantial, and area B would probably have made a significant negative contribution to the net benefits of the program.)

SPECIAL USER GROUP TRAVEL

Two changes in shared taxi fares were experienced by the elderly and handicapped residents of Danville who registered for the RTR program (Case Study S5): the first a fare reduction of approximately 75 percent in December of 1975 when the program began, and the second a fare increase of approximately 50 percent. McGillivray (1978) has

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1. To ensure that the impact on consumer surplus can be defined unambiguously, we must assume that the income elasticities of demand for the modal alternatives are equal. This condition and alternative procedures for estimating the change in consumer surplus are discussed in detail by Neuburger (1971).

shown that the arc fare elasticity for each of these changes was approximately -0.6. If we assume that this arc fare elasticity is constant along the demand curve for shared taxi services for the elderly and handicapped, we can represent the demand as

$$Q = CP^{-0.6}$$

where Q = number of shared taxi trips taken by RTR eligibles per month

P = user payment for RTR eligibles

C = constant

Using RTR ridership during the first phase of the program and expressing fare payments in 1979 dollars, we can calculate C as follows:

$$\begin{aligned} C &= QP^{0.6} \\ &= 8500\ (0.38)^{0.6} \\ &= 4757 \end{aligned}$$

That is, $Q = (4757)P^{-0.6}$

Hence for P = \$0.76 (the average RTR payment after January 1977) Q = 5608; and for P = \$1.42 (the average user payment in the absence of the RTR program) Q = 3850, as shown in figure C.4.

The net consumer surplus N generated by reducing the user payments for RTR registrants from \$1.42 to \$0.38 is shown by the shaded area in figure C.3. This can be calculated as

$$\begin{aligned} N &= 3850\ (1.42 - 0.38) + \int_{3850}^{8500} P\,dQ - 0.38\ (8500 - 3850) \\ &= 4004 + \int_{3850}^{8500} \left(\frac{4757}{Q}\right)^{1.67} dQ - 1767 \\ &= 4004 + \left[\frac{(4757)^{1.67}\ Q^{-0.67}}{-0.67}\right]_{3850}^{8500} - 1767 \\ &= 4004 + \left[-4812 + 8181\right] - 1767 \\ &= 4004 + 1602 \\ &= 5606 \end{aligned}$$

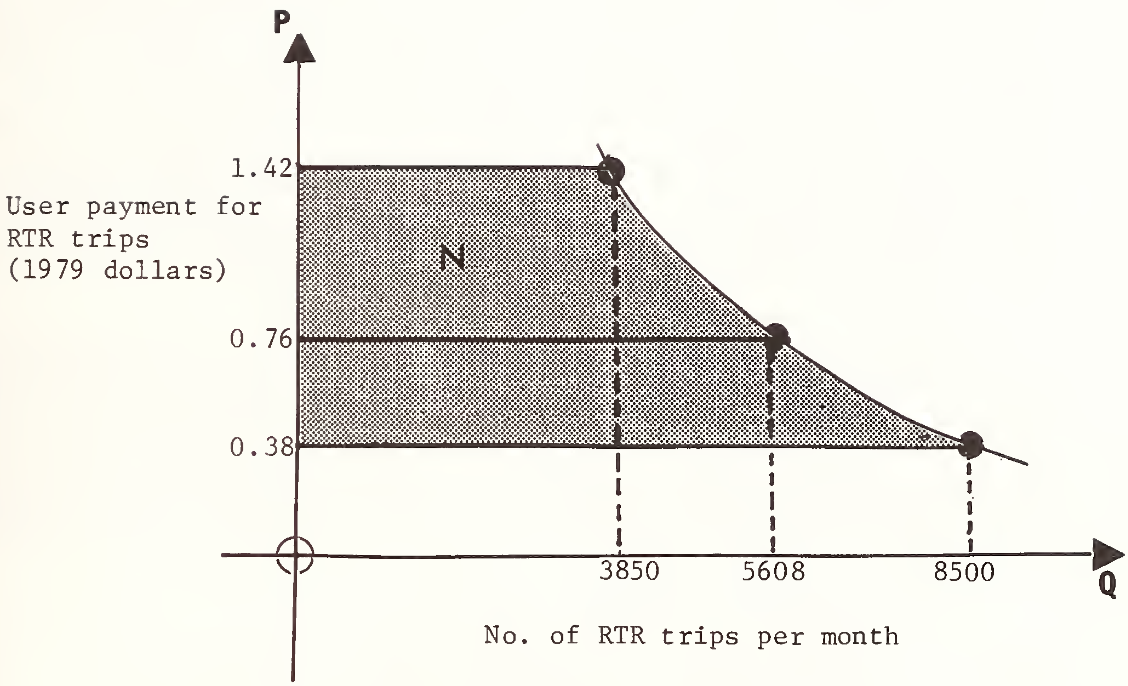

FIGURE C.3

DEMAND FOR SHARED TAXI TRIPS
BY RTR ELIGIBLES

Hence, assuming a constant new level of ridership of 8500 per month, the increase in consumer surplus generated by the 75 percent fare reduction is \$5606 per month. Of this total, \$4004 or \$1.04 per trip corresponds to the "old" trips which continue to be made at lower fares, and \$1602 or \$0.34 per trip corresponds to the new trips generated by the program. The overall average increase in consumer surplus is \$0.66 per trip in 1979 dollars, or \$0.74 in 1980 dollars.

GENERAL PURPOSE TRAVEL

The Atlanta 1972 transit system fare reduction and service increase example was analyzed as follows. Kemp (1974) presents several time series regression equations, derived from monthly operating data for the system over a period of three years spanning the fare change[2], and Kemp's equation D3 has been chosen for use here. It relates the monthly patronage volume (in "originating" or "revenue" trips) to the bus miles operated, the base fare in current dollars, a sequencing variable, and a set of twelve monthly dummy variables to capture seasonal effects. Both the ridership and the bus miles variables were divided by the number of working days in the month to normalize for varying month lengths.

Figure C.4 plots the monthly ridership levels over the period for which the equation was derived. It is apparent that there were strong seasonal variations in patronage, but the dummy variables were able to capture these quite well. In order to average out the seasonal effects, one can take the mean value of the coefficients of the twelve monthly dummy variables and treat it as a constant in the equation.[3] This simplification produces

$$q = 196{,}100 - 110{,}800p + 759m - 11{,}120 \ln t$$

where q is the month's originating trips per working day;
p is the base fare in current dollars;
m is the month's volume of bus miles (in thousands) per working day; and
t is a sequencing variable for each month, set at 1 for January 1970.

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2. A detailed guide to estimating similar time series ridership models and using them for short-range planning purposes is provided by Kemp (1981).

3. Note that the resulting equation is not identical to the one which would have been obtained if the original estimation had not included the monthly dummy variables. In such a case, specification biasses would have affected the values of the coefficients for other variables.

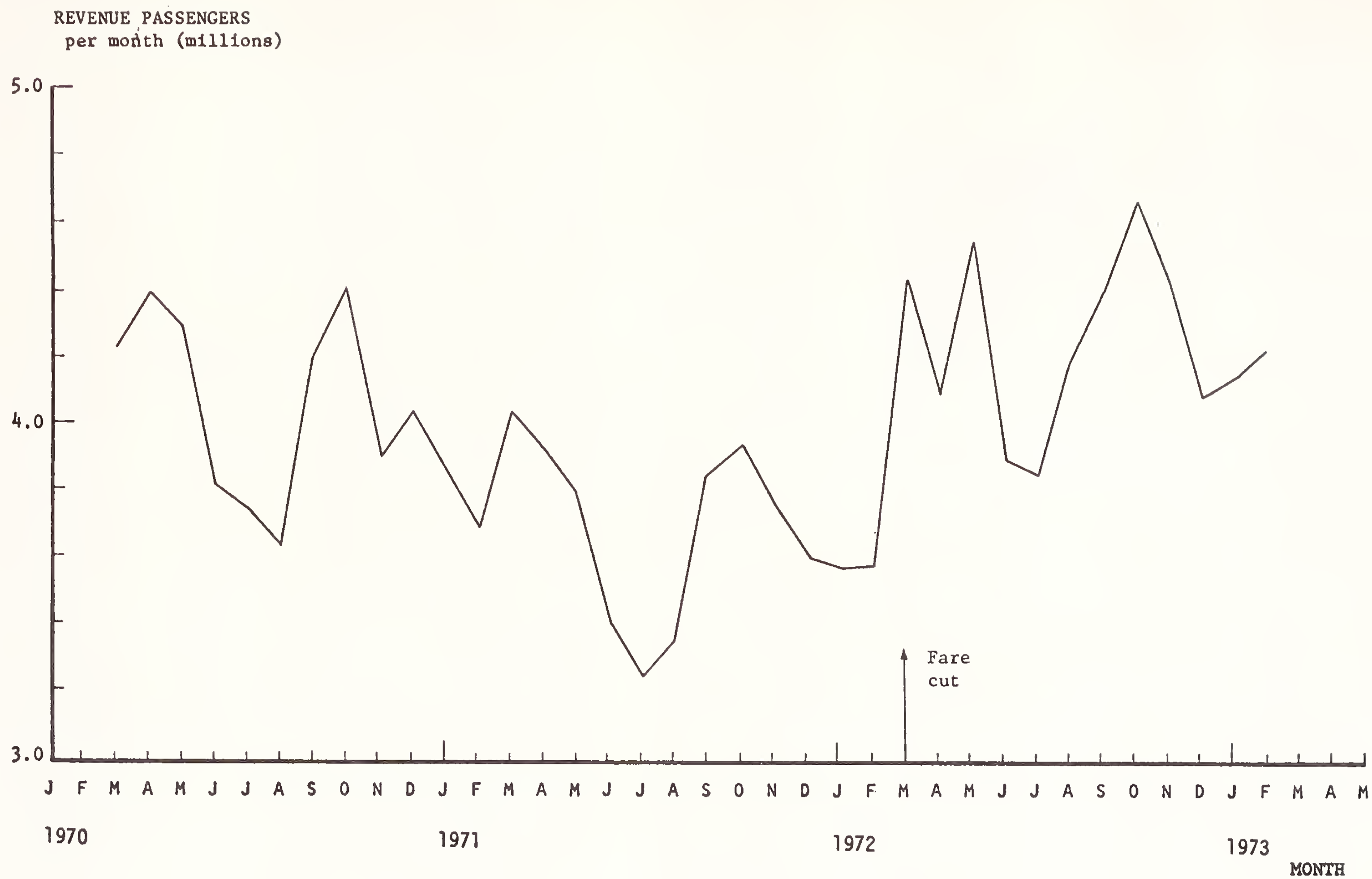

FIGURE C.4

ATLANTA BUS RIDERSHIP BY MONTH

The variable t represents the net effect of all of those influencing factors not explicitly included in the equation but which might be expected to change in an approximately linear fashion over time: changes in the price and service characteristics of competitive automobile trips and changes in public tastes are probably the best examples. The coefficient of the t variable illustrates that the system was experiencing a quite sizable underlying secular decline in patronage over the study period, modulated of course by the seasonal variations and the effects of the fare and service changes.

If we consider this statistically-estimated relationship in terms of the usual two-dimensional (price/quantity) demand schedule, the equation represents a family of parallel demand lines of general form

$$q = A_x - Bp$$

B is the constant coefficient for the fare (110,800), while the value of A_x varies both over time and with the volume of bus miles supplied. An increase in bus miles increases A_x and shifts the demand line to the right; however, over time A_x is gradually declining and the demand curve shifting leftwards.

Consider now the set of demand lines corresponding to the situation in the months immediately preceding and following the fare change. For simplicity, we will use values averaged over a twelve month period, although one could quite easily make separate calculations for each month using such a time series model as this, adding together the (properly deflated and discounted) monthly benefit estimates over whatever time period is chosen for analysis.

In Figure C.5, the line D_o (corresponding to A_o = 220,596) represents the demand curve averaged over the twelve months preceding the fare reduction[4]. At the original price p_o the level of ridership is q_o, represented by point N on the line. The line D_1 (with A_1 = 215,373) represents the situation averaged over the twelve months following the fare cut, but with the level of supply set equal to the average for the preceding twelve months. In other words, the shift between D_o and D_1 solely represents the secular decline in patronage which was occurring completely independently of the fare cut: the change in consumers' surplus in moving from D_o to D_1 should not, therefore, be considered as relevant to the benefit change associated with the fare reduction.

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4. It should be readily apparent that this diagram is not to scale and is designed for demonstrative purposes only. In a correctly scaled diagram the three demand curves would be much closer together and both fare levels, p_o and p_1, would be in the inelastic region near the bottom of the diagram.

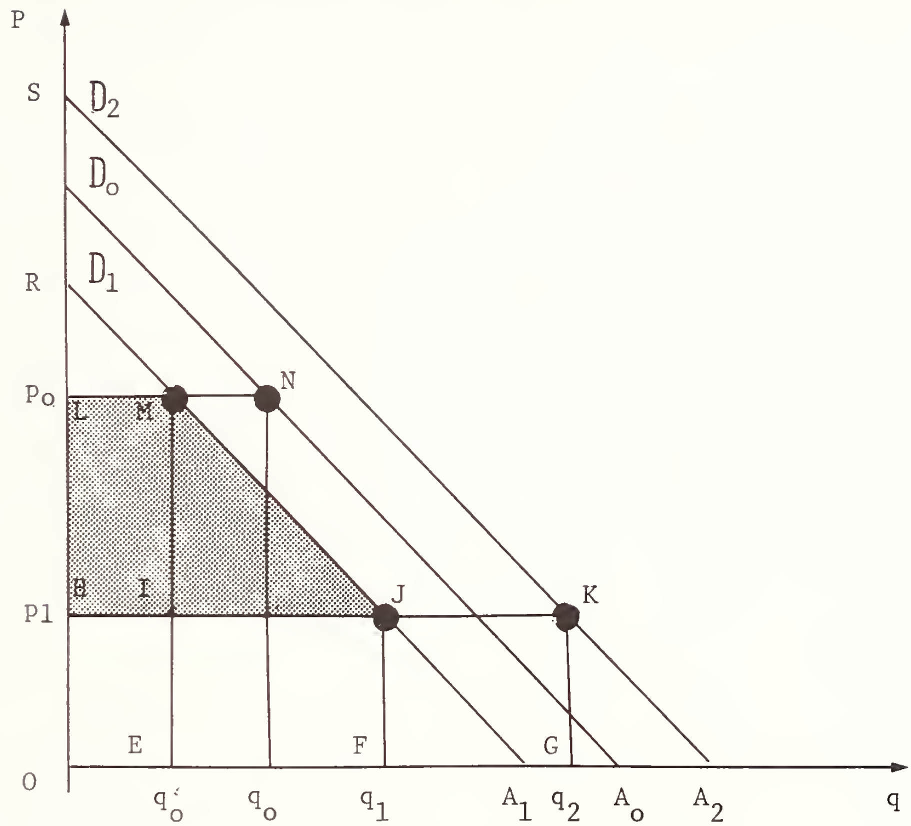

FIGURE C.5

DEMAND FOR ORIGINATING TRIPS ON THE ATLANTA SYSTEM

The point M, then, represents the hypothetical level of ridership, q_o, which would have been expected over the year following the fare change had the fare and supply level remained as in the previous year. When the fare was reduced to p_1, the patronage then grew to q_1, represented by point J on the same demand line. As in previous price change examples, the change in consumers' surplus is represented by the area of the trapezoid HJML. Simple algebra shows this area to be given by

$$\Delta \text{ user benefits} = \left[q_o' + \tfrac{1}{2}(q_1 - q_o')\right] (p_o - p_1)$$

$$= \left[A_1 - \tfrac{1}{2}B(p_o + p_1)\right] (p_o - p_1)$$

In the Atlanta case, therefore,

$$\Delta \text{ user benefits} = \left[215{,}373 - (\tfrac{1}{2} \times 110{,}800 \times 0.55)\right] \times 0.25$$

$$\approx \text{ \$46,226 per working day or \$11.56 million over the year.}$$

Of this amount, the area HIML ($10.69 million per year) is associated with "existing trips", those which would have been made at the higher price in any case.

If, for comparative purposes, we adopt a five-year period over which to calculate the costs and benefits, extension of this calculation results in a mean annual user benefit for the fare reduction of $16.41 million in 1980 prices. The computation for each year follows that for the first year in assuming that the bus miles supplied stays fixed at the mean level observed before the fare reduction, but that secular decine is occurring in the ridership throughout as a result of external factors.

When the volume of bus miles supplied is increased, the demand curve shifts rightwards to D_2 (with A_2 = 222,125). The resultant ridership is that which was actually observed on average over the year following the fare change, q_2, represented by point K. The consumers' surplus before this service expansion was triangle HJR and afterwards was HKS; the difference is represented by the trapezoid JKSR. Algebraically,

$$\begin{aligned}\triangle \text{ user benefits} &= \tfrac{1}{2}\left[(A_2/B - p_1)q_2 - (A_1/B - p_1)q_1\right] \\ &= \left[(A_2^2 - A_1^2)/2B\right] - (A_2 - A_1)p_1 \\ &= 13{,}330.26 - (6{,}752 \times 0.15) \\ &\approx \$12{,}317 \text{ per working day or } \$3.08 \text{ million over the year.}\end{aligned}$$

Computation of the mean annual user benefit deriving from the first year's service increment, averaged over a five-year period, results in an estimate of $4.37 million in 1980 prices. Because it is probable that the patronage response to the first year's increase in bus miles was not fully stabilized by the end of that year, the model is likely to have underestimated the total change in consumers' surplus.

Several points are noteworthy about these calculations. Note first that the observed "before" and "after" ridership points N and K (and particularly the "before" point) are only peripherally relevant to the user benefit calculations: it is the analysis of a longer time series of patronage levels which has permitted the identification of the demand lines and hence the consumer surplus changes. Secondly, the algebraic expressions for the user benefits can be expressed in terms of the coefficients of the original time series equation and the mean "before" and "after" values of the m and t variables -- these details were subsumed above into the numerical constants A_x. Even in this oversimplified demonstration, however, deriving such expressions produces greater algebraic complexity rather than any simplification. But in a more careful calculation of the change in consumers' surplus, it would be relatively easy to write a computer program to calculate

and accumulate the (properly deflated and discounted) change in user benefits on a month by month basis using the time series model coefficients and the observed values of the influencing variables in each month.

Finally, the time horizon to be considered merits some discussion. In the case of a fare change alone, there is some empirical evidence to suggest that the ridership response has usually stabilized after a period of six to nine months. The evidence on the time profile of the response to service changes is very sparse, but considering that service changes are usually more subtle in nature, may be implemented more gradually, and receive less media attention, one would expect the patronage reaction to develop more slowly. It seems likely, therefore, that the ridership response to the MARTA service additions (which essentially started to be implemented some three months after the fare cut) was not fully realized within the time frame chosen for the simple calculations above, and that the user benefits from the service expansion are thereby underestimated.

For the Jacksonville 1978 fare increase, the estimated monthly patronage equation, after averaging out purely seasonal effects, is[5]

$$\ln q = 2.3681 - 0.2522 \ln p + 0.7375 \ln m + 0.1803 \ln g - 0.0015t$$

where q is the month's average of originating trips per day;
p is the base fare in constant 1967 dollars;
m is the month's average volume of bus miles per day;
g is the average pump price of gasoline in Jacksonville, in constant 1967 dollars; and
t is a sequencing variable for each month, set at 1 for January 1976.

The situation can be regarded as analogous to the Atlanta example, except that here the functional form is hyperbolic and the price change is in the opposite direction. The equation can be simplified to the form

$$q = A_x p^{-B}$$

in which, as before, the constant A_x subsumes the effects (under a given set of circumstances) of all influencing variables other than p. The constant B is the numerical value of the fare elasticity (0.2522). The particular demand curve relevant to this evaluation is that in

5. This is equation B1 of Charles River Associates, Inc. (1980). It was estimated over the 42-month period from January 1976 through June 1979, and thus excludes behavior in the last three months considered in this case study. Since gasoline prices rose rapidly through those three months, our use of the equation involves a significant extrapolation.

which the "external" conditions not under the control of the transit agency -- the gasoline price and sequencing variables -- are given their average values over the twelve months following the fare change, while the bus miles variable takes its average value over the twelve-month period preceding the fare change. In this case, the value of A_x is 25,006. Table C.1 shows the predicted ridership and farebox revenue per day from this demand curve, corresponding to the mean fare levels existing over the twelve-month periods immediately before and

TABLE C.1

ESTIMATED IMPACTS OF THE JACKSONVILLE FARE INCREASE

	averages over twelve-month period	
	"before"	"after"
Deflated fare, p (1967 $)	0.1308	0.1661
Originating trips per day, q (thousands)	41.77	39.33
Revenue per day (1967 $ thousands)	5.46	6.53

after the fare increase. The volume of originating patrons is judged to have dropped by about 2.44 thousand per day or 891 thousand per year due to the price change -- this represents a ridership loss of almost 6% from the pre-increase level. If this ridership fall is assumed to continue over a five-year program period, the mean annual discounted loss is 743 thousand.

The associated revenue increase was about $390 thousand per year in 1967 prices, equivalent to $783 thousand at the time of the fare change and $963 thousand in 1980 dollars. The five-year discounted average at 1980 prices is $802 thousand. The change in consumers' surplus can easily be seen to be given by

$$\Delta \text{ user benefits} = \int_{p_o}^{p_1} q \, dp = \int_{p_o}^{p_1} A_x p^{-B} \, dp$$

$$= \frac{A_x}{1 - B} \left[p_1^{1-B} - p_o^{1-B} \right]$$

$$= \frac{25{,}006}{0.7478} \left[0.1661^{0.7478} - 0.1308^{0.7478} \right]$$

$$\approx \$1{,}428 \text{ per day or } \$521 \text{ thousand per year.}$$

At 1980 prices, this is equivalent to a loss of consumer benefits of \$1.29 million per year. Continuing over a five-year program period and discounted, the loss averages \$1.07 million per year.

Using a model of this hyperbolic type to forecast the average annual financial implications over a five-year performance period provides an interesting problem. Patronage is influenced in the equation by three external factors which must be projected: general inflation, as measured by the consumer price index; Jacksonville gasoline prices; and a general secular decline captured by the sequencing variable. For these calculations we used the actual values of the CPI and gasoline price data for the first three years of the period (October 1978 through September 1981), and projected monthly values for the last two years using the average compound growth rates experienced over the first three years. Planners using this approach to appraise alternative short-term operating policies would need to forecast the likely "background conditions" for all five years, of course, and this scenario would be held constant for all of the options under consideration.

Table C.2 shows the projected mean values of A_x, p_o, and p_1 for each of the years following the fare increase, and then uses these values to estimate the ridership, revenue, and user benefit implications in each of the five years. It will be noted that the ridership loss attributed to the fare increase is sharply higher after the first year, and this is due to relative changes in the background conditions. First, general inflation is pushing down the real values of the "before" and "after" fares, and the model suggests that this should increase the difference between the patronage at the two fares. Secondly, quite rapid growth in the retail price of gasoline helps to magnify the calculated ridership response to the price change, offset slightly by the secular decline effect. It should be noted that these changes extend outside the range of experience used to estimate the regression model, and the figures should therefore be used circumspectly. We suspect that Table C.2 overstates the true sensitivity to the background conditions.

TABLE C.2

PROJECTED JACKSONVILLE IMPACTS OVER THE FIVE-YEAR PERIOD (1979-83)

	Year				
	1979	1980	1981	1982	1983
Estimated model values:					
A_x	25,006	25,693	25,330	24,993	25,034
P_o	0.1308	0.1044	0.0940	0.0842	0.0752
P_1	0.1661	0.1462	0.1315	0.1179	0.1053
Ridership loss (thousands):					
from model	891	1,348	1,366	1,385	1,427
discounted	891	1,226	1,129	1,041	975
Revenue increase (thousands):					
from model (1967 $)	390	495	451	410	378
undiscounted 1980 $	963	1,224	1,115	1,014	933
discounted 1980 $	963	1,112	921	761	637
User benefit change (thousands):					
from model (1967 $)	521	662	603	549	505
undiscounted 1980 $	1,288	1,636	1,490	1,355	1,248
discounted 1980 $	1,288	1,488	1,232	1,018	852

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Selecting Promising Actions

Assessing Benefits and Cost-Effectiveness

High-Density Home-To-Work Travel Examples

Special User Group Travel Examples

General Purpose Travel Examples

Automobile Management and Pricing Examples

Appendix A: Estimating Changes in Vehicle Miles of Travel (VMT)

Appendix B: Computing Program Assessment Measures

Appendix C: Estimating User Benefits

References

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